Annual Groundwater System Performance Report – 2001

Corrective Action Groundwater Monitoring Program Permit No. WAD 009 252 891 Part V.C.

Prepared for

Reichhold, Inc.
Tacoma Facility

Prepared by

CH2MHILL
777 108th Avenue NE
P.O. Box 91500
Bellevue, Washington 98009-2050

February 2002

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REICHHOLD
A DIC GROUP COMPANY
Creatively connecting knowledge and application.

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TO: Chief, Waste Management Branch
U.S. Environmental Protection Agency, Region 10

FROM: Alan S. Jeroue
Reichhold, Inc.

DATE: February 15, 2002

RE: Reichhold, Inc., Tacoma, WA
Annual Groundwater System Performance Report - 2001

Enclosed is the Reichhold Tacoma Facility, Annual Groundwater System Performance Report - 2001. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Alan S. Jeroue
Tacoma Site Manager

Alan S. Jeroue

Date 2-15-02

Attachment

cc: Ms. Robbie Hedeen
U.S. Environmental Protection Agency, Region 10
Supervisor, Hazardous Waste Section
Washington State Department of Ecology
Environmental Commission
Puyallup Indian Tribe
Port of Tacoma

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Acronyms

ACL	Alternative Concentration Limit
ASARCO	American Smelting and Refining Company
CAMP	Corrective Action Monitoring Program
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
EW	extraction well
ft/d	feet per day
ft/ft	feet per foot
GWPS	groundwater protection standard
µg/L	micrograms per liter
mg/L	milligrams per liter
MTCA	Model Toxics Control Act
MW	monitoring well
NGVD	National Geodetic Vertical Datum
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PQL	practical quantitation limit
PZ	piezometer
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RFI	RCRA facility investigation
SID	shallow interceptor drain
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
VOC	volatile organic compound

Executive Summary

This 2001 Annual Groundwater System Performance Report for Reichhold, Inc.'s Tacoma facility has been prepared in accordance with the Corrective Action Monitoring Program (CAMP) of the Resource Conservation and Recovery Act (RCRA) Permit No. WAD 009 252 891, Part V.C. (the permit). In compliance with the permit, four quarters (January, April, July, and October) of groundwater monitoring were conducted in 2001.

This report demonstrates that Reichhold's operation of the corrective measure systems complies with the groundwater containment and clean-up objectives at the facility.

Compliance with Groundwater Quality Permit Objectives

Groundwater samples collected from shallow and intermediate aquifer wells in July 2001 were analyzed for constituents listed in Table 7 of the permit (31 organic and 18 inorganic constituents). Water quality monitoring in the deep aquifer was discontinued following the October 1994 quarterly event in accordance with the permit.

In July 2001, the Groundwater Protection Standard (GWPS) for 23 of the 31 organic constituents and 12 of the 18 inorganic constituents listed in Table 7 of the permit were met in all sampled shallow aquifer wells.

In the intermediate aquifer during July 2001, the GWPS for 25 of the 31 organic constituents and 9 of the 18 inorganic constituents listed in Table 7 of the permit were met in all sampled intermediate aquifer wells.

The principal organic constituents that exceeded their GWPS in the shallow and intermediate aquifers during 2001 are the following:

- Chlorinated phenols (primarily pentachlorophenol [PCP] and 2,4,6-trichlorophenol)
- Formaldehyde
- Trichloroethene (TCE)
- Vinyl chloride

Groundwater Quality Trend Analysis

A statistical trend analysis using the Kendall test was performed to determine the presence or absence of statistically significant trends in concentration levels over the entire monitoring period to date (January 1985 through 2001). Wells selected for trend analysis were the 27 well-parameter combinations where the GWPS for the indicator parameters listed in Table 5 of Reichhold's RCRA permit were exceeded during 2001. There are 13 well-parameter combinations for the shallow aquifer and 14 for the intermediate aquifer.

Of the 13 shallow well-parameter combinations included in the Kendall trend analysis, seven exhibited no statistically significant parameter concentration trends over the period of

record. Of the six shallow aquifer well-parameter combinations exhibiting significant trends, three were increasing and three decreasing over the period.

Statistically significant increasing trends were observed in MW-14(S) for the constituents 2,4,6-trichlorophenol (a degradation product of PCP), TCE, and vinyl chloride. It should be noted that, while the Kendall trend analysis of the entire monitoring period indicates an increasing trend for 2,4,6-trichlorophenol at MW-14(S), concentrations have actually been decreasing in this well since 1999.

Statistically significant decreasing trends were observed in MW-42(S)2 for PCP and TCE and in MW-56(S) for molybdenum.

Thirteen of the 14 well-parameter combinations tested in the intermediate aquifer exhibited statistically significant trends. Of these, 11 well-parameters combinations exhibited decreasing concentration trends. Formaldehyde was decreasing in all six intermediate aquifer wells that exceeded the GWPS: MW-7(I), MW-36(I), MW-39(I), MW-46(I), MW-50(I), and MW-53(I). Concentrations in MW-30(I) exhibited decreasing trends for three constituents: 2,4,6-tricholophenol, PCP, and TCE. Trends for molybdenum in intermediate wells were inconsistent, with significant declines observed in MW-53(I) and increasing trends in MW-45(I) and MW-48(I). There are no apparent trends in vinyl chloride concentrations in MW-53(I).

Overall, the trend analyses performed indicate that concentrations of most indicator parameters in both the shallow and intermediate aquifers are either declining or exhibiting no trend. Fourteen of 27 well-parameter combinations, representing 52 percent of the test well-parameter combinations, exhibit statistically significant declining trends. Eight of the same 27 well-parameter combinations, representing 30 percent, exhibit no statistically significant trend over the period. Statistically significant increasing trends are limited to five of the 27 well-parameter combinations, or about 18 percent. Increases in shallow aquifer well-parameter combinations, which include 2,4,6-trichlorophenol, TCE, and vinyl chloride, are limited to one well: MW-14(S). Increases in the intermediate aquifer well-parameter combinations are limited to a single parameter, molybdenum, in two wells: MW-45(I) and MW-48(I).

Compliance with Hydraulic Performance Standards

Five hydraulic performance standards are specified in Part V.C.(1)(f)(iii) of the permit. Table ES-1 describes each performance standard and summarizes compliance during 2001.

As presented in Table ES-1, compliance with shallow aquifer Performance Standards 1 and 2 was demonstrated during all four quarters of 2001. Compliance with intermediate aquifer Performance Standards 3 and 4 were met during all four quarters of monitoring in 2001. Compliance with Performance Standard 5 was evaluated using an analysis of the net groundwater flow between cluster wells completed in the intermediate and deep aquifers over all four quarters of 2001. The analysis demonstrated that an upward vertical groundwater flow direction occurred across the confining layer separating the intermediate and deep aquifers in all six of the intermediate/deep well clusters.

Pentachlorophenol Removal and Treatment

During 2001, 388 pounds of PCP were treated and removed from the groundwater by the on-site treatment plant. An evaluation of the trend in mass removal effectiveness of the Tacoma facility extraction system illustrates that the extraction system initially removed groundwater containing fairly high concentrations of PCP (9.0 milligrams per liter [mg/L]). However, the average concentration of PCP extracted by the treatment system has dropped substantially since 1992. PCP concentrations have reached an asymptotic level of about 1.1 mg/L.

This type of trend is commonly observed in pump-and-treat systems, particularly when organic constituents that adsorb to the aquifer matrix are involved. Although the extraction system continues to be effective at hydraulically containing PCP in groundwater at the site, continued operation of the groundwater extraction system by itself is unlikely to achieve the current groundwater protection standard of 0.001 mg/L.

Summary of Compliance with Permit Objectives

Table ES-2 summarizes compliance with the permit objectives in 2001. Of the shallow aquifer CAMP wells, 73 percent met GWPS for organic constituents or were dry. Forty percent of the shallow aquifer CAMP wells met GWPS for inorganic constituents. Inorganic constituents that exceeded GWPS in shallow aquifer wells are commonly antimony, manganese, molybdenum, and copper. These metals are associated with ASARCO smelter slag used as fill material and, with the exception of molybdenum, are not associated with past manufacturing processes at the Reichhold Tacoma facility.

All shallow aquifer wells either met the GWPS or were hydraulically contained. These findings indicate that the shallow aquifer complies with the groundwater containment and clean-up objectives at the facility.

In the intermediate aquifer wells, 63 percent met GWPS for organic constituents during 2001. This percentage is the same as noted in the 2000 data. Two wells, or 11 percent of the intermediate aquifer wells, met GWPS for inorganic constituents. This is up from 0 percent in 2000. The remaining wells did not meet GWPS due mainly to detections of antimony and, to a lesser degree, manganese, molybdenum, and copper.

All of the intermediate wells either met the GWPS or were hydraulically contained, indicating that the intermediate aquifer met the groundwater containment and clean-up objectives at the facility. In conclusion, Reichhold's operation of the corrective measure systems complies with the permit's groundwater containment and clean-up objectives at the facility.

TABLE ES-1
2001 Summary of Compliance with Hydraulic Performance Standards
Reichhold, Inc., Tacoma, WA

Performance standard[a]	Aquifer	Description	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
1	Shallow	SID[b] maintains a water level lower than the surrounding groundwater table.	Yes	Yes	Yes	Yes
2	Shallow	Shallow aquifer flow lines are converging to the SID from the area beyond the drain and the area internal to the drain.	Yes	Yes	Yes	Yes
3	Intermediate	Extraction systems are capable of recovering the groundwater both on site and off site that has been adversely impacted by releases from the facility.	Yes	Yes	Yes	Yes
4	Intermediate	Groundwater extraction systems are capable of preventing nonpermitted discharges into the Blair Waterway and of reversing the gradient between the Blair Waterway and the off-site extraction system.	Yes	Yes	Yes	Yes
5	Intermediate/ deep	Groundwater extraction systems are capable of maintaining net groundwater flow from the deep aquifer to the intermediate within the influence of the intermediate groundwater system[c].			Yes	

[a]As described in Reichhold's RCRA Permit [V.C.(1)(f)(iii)].

[b]SID: Shallow Interceptor Drain

[c]Based on net vertical groundwater flow between the deep and intermediate aquifers during 2001; upward net vertical flow direction noted in all of the six cluster well locations.

TABLE ES-2
2001 Summary of Compliance with Permit Objectives
Reichhold, Inc., Tacoma, WA

Wells	Meet GWPS[a]		Meet GWPS or demonstrate hydraulic containment	Meet GWPS or demonstrate hydraulic containment or exhibit decreasing trend
	Inorganic constituents	Organic constituents		
Shallow aquifer wells	40%	73%	100%	100%
Intermediate aquifer wells	11%[b]	63%	100%	100%

[a]Table 7 of Reichhold's RCRA Permit.

[b]This value is primarily due to antimony, which exceeded GWPS in 15 of 19 intermediate wells. Antimony is associated with the ASARCO smelter slag and is not associated with past manufacturing processes at the site.

SECTION 1

Introduction

This 2001 Annual Groundwater System Performance Report for Reichhold, Inc.'s Tacoma facility has been prepared in accordance with the Corrective Action Monitoring Program (CAMP) of Reichhold's Corrective Action and Storage Resource Conservation and Recovery Act (RCRA) Permit No. WAD 009 252 891, Part V.C. (the permit). This report demonstrates that Reichhold's operation of the corrective measure systems complies with the groundwater containment and clean-up objectives at the facility.

1.1 Background and Current Status of the Facility

Reichhold has been working with the regulatory agencies (United States Environmental Protection Agency [EPA] Region 10 and the Washington State Department of Ecology [Ecology]) since 1986 to investigate, remediate, and permit the Tacoma facility. Reichhold has conducted numerous investigations over that time, including a RCRA facility assessment (RFA) and a RCRA facility investigation (RFI, referred to as the Preclosure Investigation). Since the basic site characterization work was completed in the late 1980s, Reichhold has performed ongoing monitoring and focused site investigations as needed to support ongoing corrective actions at the site. Reichhold also installed several interim measures including the extraction, containment, and treatment system for groundwater, which is the focus of this annual report. Reichhold's permit became effective on December 4, 1988. A renewal application was submitted to the agencies on June 2, 1998.

1.1.1 Groundwater Monitoring Program

Per the RCRA permit conditions, groundwater monitoring was initially conducted under the Precorrective Action Monitoring Program (PCAMP) beginning in January 1989 through March 1993. PCAMP took place during the installation of the interim hydraulic containment system for the shallow and intermediate groundwater aquifers. Once this containment system was installed, Reichhold began monitoring under CAMP of the permit (July 1993 to present).

Reichhold submitted a permit modification request on December 16, 1996, to EPA that changed the groundwater protection standard (GWPS) for formaldehyde and inorganic constituents. The modification included revising the GWPS for formaldehyde, currently at the practical quantitation limit (PQL), to a risk-based level as allowed by the permit. Additionally, for inorganics that are not associated with past practices at the facility and/or are associated with the American Smelting and Refining Company (ASARCO) smelter slag or other fill material used in the area surrounding the property, the modification request changed the current GWPS to either background values for the area or risk-based levels appropriate for the area (Model Toxics Control Act regulations (MTCA), Method C). Reichhold has not received a response from EPA on this permit modification request.

1.1.2 Site Clean-Up

In addition to installing and operating the interim hydraulic groundwater containment systems, key site clean-up achievements have included clean closing the wastewater ponds (a RCRA-regulated hazardous waste land disposal unit), remediating two solid waste management units, or SWMUs (septic tank area and unit 49), and initiating a pilot soil treatment process for soil from identified pentachlorophenol (PCP) source areas. During the summer of 1997, soil from the former PCP plant (a RCRA-regulated unit) and the North Extension (a SWMU) was excavated and placed in on-site soil cells where an innovative biological amendment is being evaluated. To date, Reichhold has excavated thousands of cubic yards of soil from the site, analyzed several thousand soil and groundwater samples, and spent more than $35 million completing RCRA requirements and responding to agency and citizen concerns about the site. Reichhold's record demonstrates responsible stewardship of the facility under the RCRA program.

1.2 Report Organization

This annual report is organized into three major sections:

- Groundwater quality (Section 2)
- Hydraulic containment (Section 3)
- PCP removal and treatment (Section 4)

1.2.1 Section 2

In Section 2, groundwater monitoring results from July 2001 are provided and compared to the GWPS listed in Table 7 of the permit. Time-concentration plots for wells with constituents exceeding GWPS for organic compounds or molybdenum were evaluated to fulfill the requirements of Part V.C.(1)(f)(ii) of the permit. These time-concentration plots show indicator constituent concentrations over time for groundwater samples obtained from selected CAMP monitoring wells, demonstrating performance effectiveness of the corrective measures. A statistical trend analysis is described for selected indicator constituents.

1.2.2 Section 3

Section 3 presents a compliance evaluation with the five system hydraulic performance standards specified in Part V.C.(1)(f)(iii) of the permit. Four quarters of groundwater elevation data are presented on groundwater elevation contour maps to assess whether the operation of the corrective measures systems complies with the hydraulic performance standards and with the groundwater containment and clean-up objectives at the facility. Groundwater gradients and flow velocity estimates for the shallow, intermediate, and deep aquifers are also summarized.

1.2.3 Section 4

Section 4 summarizes the amount of PCP extracted and treated by the groundwater extraction system during 2001 to demonstrate the remedial progress and effectiveness of the groundwater remedial system at the facility. In addition, the trend of average PCP

concentrations in treatment plant influent since the groundwater extraction system began operating in 1992 provides information on the trend in mass removal effectiveness of the site extraction system.

SECTION 2

Groundwater Quality

This section describes the 2001 groundwater sampling results for the shallow and intermediate aquifers. More detailed descriptions of the quarterly sampling results and analytical data quality for 2001 events are provided in the following reports:

- *Quarterly Groundwater Monitoring Results – January 2001* (CH2M HILL, March 2001)
- *Quarterly Groundwater Monitoring Results – April 2001* (CH2M HILL, July 2001)
- *Quarterly Groundwater Monitoring Results – July 2001* (CH2M HILL, October 2001)
- *Quarterly Groundwater Monitoring Results – October 2001* (CH2M HILL, November 2001)

2.1 Sampling Program and Comparison to GWPS

2.1.1 Shallow Aquifer

During 2001, groundwater samples collected in July from shallow and intermediate aquifer CAMP wells were analyzed for constituents listed in Table 7 of the permit. Samples were collected from each CAMP well capable of yielding sufficient water for sampling. Because the shallow aquifer is thin and tends to go dry in areas, especially during the summer, some wells could not be sampled. In July 2001, 11 of the 15 CAMP shallow aquifer wells scheduled for sampling had sufficient water for sample collection. Four shallow aquifer wells, MW-11(S)2, MW-33(S), MW-54(S), and MW-57(S), were dry at the time of sampling. In addition, MW-2(S)2 yielded only enough water to fill the volatile organic compound (VOC), semivolatile organic compound (SVOC), and metals sample containers. Polychlorinated biphenyls (PCBs) and cyanide samples were not obtained at this well.

Observations regarding groundwater quality in the shallow groundwater at the site are summarized below. Appendix A lists the analytical results and the GWPS, as listed in Table 7 of the permit, for comparison purposes. Table 2-1 compares shallow aquifer CAMP well results to GWPS since 1995. Figure 2-1 illustrates the locations of shallow aquifer wells with constituent concentrations exceeding GWPS during the July quarterly event. In July, seven of the 11 shallow aquifer monitoring wells sampled met the GWPS for all Table 7 organic constituents.

2.1.1.1 Organic Constituents

Seven of the 11 shallow aquifer monitoring wells sampled for organic constituents in July 2001 met the GWPS for all organic constituents. One well, MW-2(S)2, yielded all aliquots with the exception of cyanide and PCBs because of poor recovery of the aquifer due to seasonal low water levels.

TABLE 2-1
Shallow Aquifer Groundwater Protection Standard Comparison
Reichhold, Inc., Tacoma, WA

Shallow aquifer well	1995				1996				1997				1998				1999				2000				2001			
	Jan	Apr	Jul	Sept	Jan	Apr	Jul	Oct	Jan	Apr	Aug	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
MW-1(S)	--	--	•	--	--	•	•	--	--	•	M	--	--	•	•	--	--	M	•	--	--	--	•	--	--	--	•	--
MW-2(S)2	--	--	DRY	--	--	F	DRY	--	--	F	•	--	--	•	DRY	--	--	•	DRY	--	--	--	DRY	--	--	--	M	--
MW-4(S)	--	--	F,M	--	--	F,M	F,M	--	--	M	M	--	--	•	•	--	--	M	M	--	--	--	M	--	--	--	M	--
MW-9(S)	--	--	•	--	--	F	F	--	--	•	DRY	--	--	•	DRY	--	--	•	M	--	--	--	•	--	--	--	M	--
MW-11(S)2	--	--	DRY	--	--	F,M,P	DRY	--	--	M,P	DRY	--	--	DRY	DRY	--	--	M,P	DRY	--	--	--	DRY	--	--	--	DRY	--
MW-12(S)	--	--	DRY	--	--	F	F	--	--	M	•	--	--	M	•	--	--	M	•	--	--	--	M	--	--	--	M	--
MW-14(S)	--	--	P,M,V	--	--	P	P,M	--	--	P	V,F,P,M	--	--	V,P	V,P,M	--	--	V,P	V,P,M	--	--	--	V,P,M	--	--	--	V,F,P,M	--
MW-21(S)2	--	--	DRY	--	--	F	F,M	--	--	F	F,M	--	--	•	F,M	--	--	•	M	--	--	--	M	--	--	--	F,M	--
MW-27(S)	--	--	F	--	--	•	F	--	--	•	•	--	--	•	DRY	--	--	•	•	--	--	--	•	--	--	--	•	--
MW-33(S)	--	--	DRY	--	--	F	F	--	--	•	•	--	--	•	DRY	--	--	DRY	•	--	--	--	DRY	--	--	--	DRY	--
MW-42(S)2	--	--	V	--	--	•	V	--	--	•	DRY	--	--	V	V	--	--	•	M,V	--	--	--	V	--	--	--	V,M	--
MW-51(S)	--	--	•	--	--	•	DRY	--	--	F	•	--	--	DRY	DRY	--	--	•	•	--	--	--	DRY	--	--	--	M	--
MW-54(S)	--	--	DRY	--	--	•	DRY	--	--	•	DRY	--	--	•	DRY	--	--	•	DRY	--	--	--	DRY	--	--	--	DRY	--
MW-56(S)	--	--	M	--	--	M	M	--	--	M	M	--	--	M	M	--	--	M	M	--	--	--	M	--	--	--	M	--
MW-57(S)	--	--	DRY	--	--	•	DRY	--	--	DRY	DRY	--	--	DRY	DRY	--	--	•	DRY	--	--	--	DRY	--	--	--	DRY	--

- • Meets groundwater protection standards
- -- Not scheduled for sampling
- DRY Well was dry at time of sampling
- F Formaldehyde
- M Metals
- P Chlorinated phenols
- V Volatiles

Notes: Shaded cells represent instances where groundwater protection standards were not met.
SVOCs, PCBs, and cyanide were analyzed for but were not detected above GWPS.

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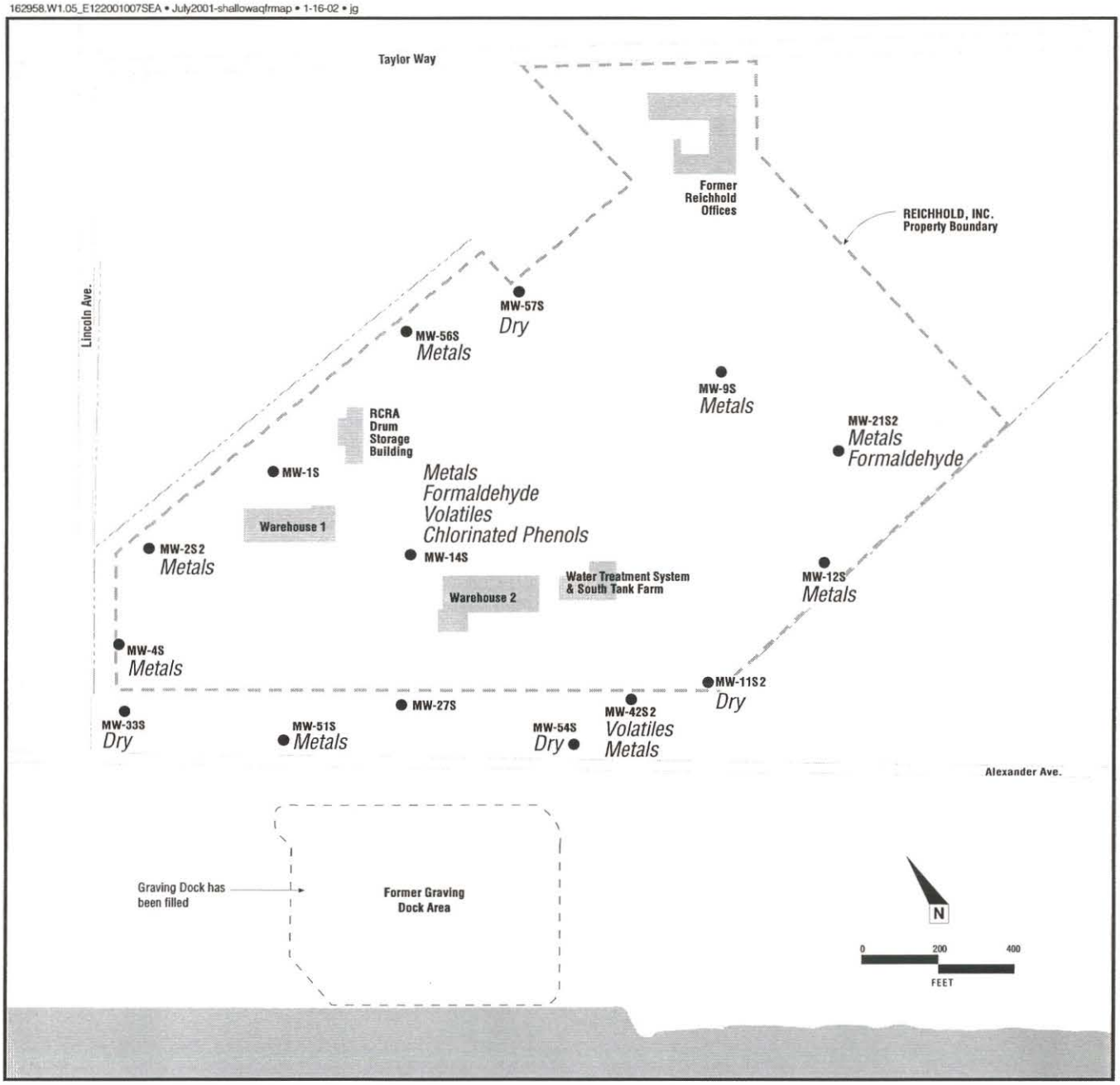


KEY

MW-17I

- Aquifer monitored
- Well number
- Well location
- Property boundary
- Ditches

Figure 2-1

Locations Where GWPS Were Exeeded (by Constituent Group) Shallow Aquifer

July 2001

Reichhold, Inc., Tacoma, WA

- The GWPS for 23 of the 31 organic constituents listed in Table 7 of the permit were met in all sampled shallow aquifer wells in July 2001. The eight organic constituents detected above GWPS in the shallow aquifer were 2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, PCP, formaldehyde, trichloroethene (TCE), and vinyl chloride.
- Chlorinated phenols are the key indicator constituents for the shallow aquifer. The chlorinated phenols, PCP, 2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, and 2,4-dichlorophenol exceeded their respective GWPS in only one of the 11 shallow aquifer wells sampled, MW-14(S). This outcome was anticipated based on previous data from this well and because MW-14(S) is located adjacent to the former PCP plant.
- Formaldehyde was detected at concentrations slightly above the GWPS of 50 micrograms per liter (µg/L) in only two shallow aquifer wells, MW-14(S) and MW-21(S)2. The concentrations of formaldehyde detected in shallow aquifer monitoring wells are far below the proposed risk-based Alternative Concentration Limit (ACL) for formaldehyde.
- TCE was detected above GWPS in two shallow wells, MW-14(S) and MW-42(S)2; vinyl chloride was detected above GWPS in MW-14(S).

2.1.1.2 Inorganic Constituents

- The GWPS for 12 of the 18 inorganic constituents listed in Table 7 of the permit were met in the 11 shallow groundwater samples analyzed for inorganics (some shallow wells were dry during the July 2001 sampling event). Inorganic constituents detected above their GWPS were antimony, copper, manganese, molybdenum, nickel, and zinc. These are the same six metals as reported for July 2000. The metals exceeding their respective GWPS are associated with ASARCO smelter slag, which has been used as fill in the vicinity of the facility and were also deposited as fugitive dust emissions from the ASARCO smelter. The presence of these metal sources has elevated the background concentrations of these metals in the soil, surface water, and groundwater in the vicinity of the facility. With the exception of molybdenum, these metals are not associated with past manufacturing processes at the site.

2.1.2 Intermediate Aquifer

Nineteen intermediate aquifer CAMP monitoring wells were sampled in July 2001. Samples were analyzed for Table 7 constituents as listed in the permit. The analytical results and the GWPS, as listed in Table 7 of the permit, are provided in Appendix A. Table 2-2 compares the intermediate aquifer CAMP well results since 1995 to GWPS. Figure 2-2 shows the intermediate aquifer wells locations with constituent concentrations exceeding GWPS during the July 2001 quarterly event. Observations regarding groundwater quality in the intermediate aquifer at the site are summarized below.

2.1.2.1 Organic Constituents

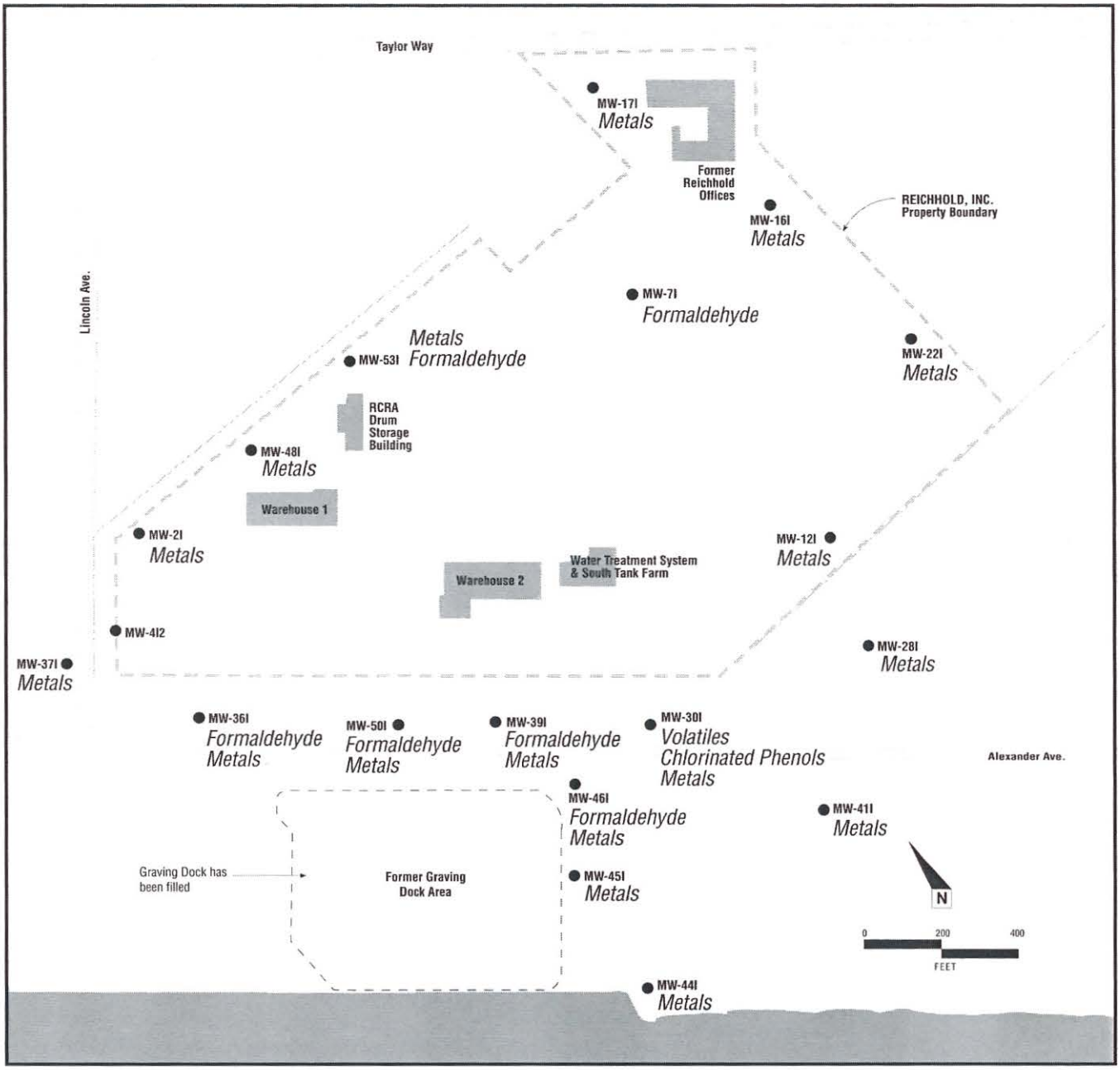
Twelve of the 19 intermediate aquifer monitoring wells sampled in July 2001 met the GWPS for all organic constituents.

TABLE 2-2
Intermediate Aquifer Groundwater Protection Standard Comparison
Reichhold, Inc., Tacoma, WA.

Intermediate aquifer well	1995				1996				1997				1998				1999				2000				2001			
	Jan	Apr	Jul	Sept	Jan	Apr	Jul	Oct	Jan	Apr	Aug	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
MW-2(I)	--	--	V,F,M	--	--	V,F,M	V,F,M	--	--	V,F,M	V,M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-4(I)2	--	--	•	--	--	•	F,M	--	--	•	M	--	--	--	M	--	--	•	•	--	--	•	M	--	--	--	•	--
MW-7(I)	--	--	F,M	--	--	F	F,M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	F	F,M	--	--	--	F	--
MW-12(I)	--	--	F,M	--	--	F	F,M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-16(I)	--	--	M	--	--	•	F,M	--	--	P	P,M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-17(I)	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-22(I)	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-28(I)	--	--	F,M	--	--	•	F,M	--	--	•	F,M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-30(I)	--	--	V,P,M	--	--	V,F,P,M	V,F,P,M	--	--	V,P,M	V,P,M	--	--	--	V,P,M	--	--	V,P,M	V,P,M	--	--	V,P	V,P,M	--	--	--	V,P,M	--
MW-36(I)	--	--	M	--	--	•	M	--	--	F	F,M	--	--	--	F,M	--	--	•	M	--	--	•	F,M	--	--	--	F,M	--
MW-37(I)	--	--	F,M	--	--	•	M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-39(I)	--	--	M	--	--	•	F,M	--	--	•	F,M,P	--	--	--	F,M	--	--	•	M	--	--	•	F,M	--	--	--	F,M	--
MW-41(I)	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-44(I)	--	--	F,M	--	--	F	F,M	--	--	F	M	--	--	--	M	--	--	•	M	--	--	•	M	--	--	--	M	--
MW-45(I)	--	--	M	--	--	F	F,M	--	--	•	F,M	--	--	--	M	--	--	M	M	--	--	M	M	--	--	--	M	--
MW-46(I)	--	--	F,M	--	--	F	F,M	--	--	F	M	--	--	--	•	--	--	•	•	--	--	•	M	--	--	--	F,M	--
MW-48(I)	--	--	V,F,M	--	--	V,F,M	V,F,M	--	--	V,F,M	V,F,M	--	--	--	V,F,P	--	--	V,P,M	V,F,P,M	--	--	V,F,M	V,F,M	--	--	--	M	--
MW-50(I)	--	--	F,M	--	--	•	F,M	--	--	F	F,M	--	--	--	F,M	--	--	•	F	--	--	•	F,M	--	--	--	F,M	--
MW-53(I)	--	--	V,F,M	--	--	V,F,M	V,F,M	--	--	V,F,M	V,F,M	--	--	--	F,M	--	--	V	F,M	--	--	V,F,M	V,F,M	--	--	--	F,M	--

- • Meets groundwater protection standards
- -- Not scheduled for sampling
- DRY Well was dry at time of sampling
- F Formaldehyde
- M Metals
- P Chlorinated phenols
- V Volatiles

Notes: Shaded cells represent instances where groundwater protection standards were not met.
SVOCs, PCBs, and cyanide were analyzed for but were not detected above GWPS.



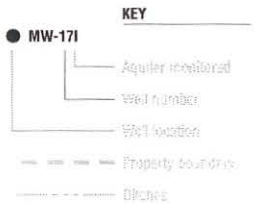


Figure 2-2
Locations Where GWPS Were Exeeded (by Constituent Group) Intermediate Aquifer
July 2001

Reichhold, Inc., Tacoma, WA

- The GWPS for 25 of the 31 organic constituents in Table 7 of the permit were met in all sampled intermediate aquifer wells in July 2001. The six organic constituents detected above GWPS in the intermediate aquifer are benzene, formaldehyde, PCP, 2,4,6-trichlorophenol, TCE, and vinyl chloride.
- Formaldehyde is the VOC that most commonly exceeds its GWPS in the intermediate aquifer, exceeding GWPS in six wells: MW-7(I), MW-36(I), MW-39(I), MW-46(I), MW-50(I), and MW-53(I). As in the shallow aquifer, chlorinated phenols are the key indicator constituents.
- PCP and 2,4,6-trichlorophenol exceeded GWPS in MW-30(I); this outcome was anticipated because MW-30(I) is located downgradient of the construction debris area.

2.1.2.2 Inorganic Constituents

- The GWPS for ten of the 18 inorganic constituents listed in Table 7 of the permit were met in the 19 CAMP intermediate aquifer wells sampled. Inorganic constituents detected above their GWPS were antimony, arsenic, cadmium, copper, chromium, manganese, molybdenum, and zinc. The metals exceeding their respective GWPS are associated with ASARCO smelter slag, which has been used as fill in the vicinity of the facility and were also deposited as fugitive dust emissions from the ASARCO smelter. The presence of these metal sources has elevated the background concentrations of these metals in the soil, surface water, and groundwater in the vicinity of the facility. With the exception of molybdenum, these metals are not associated with past manufacturing processes at the site.

2.2 Trend Analysis

A statistical trend analysis using the Kendall test was performed on 27 well-parameter combinations to determine the presence or absence of statistically significant trends in concentration levels over the monitoring period (January 1985 through July 2001). Wells selected for trend analysis were those wells where GWPS were not met for constituents from Table 5 (indicator parameters) of the permit occurred during 2001. Time-concentration plots for these well-parameter combinations are found in Appendices B and C. For cases where field duplicates were taken (2 samples from the same well for the same event), the two results were averaged prior to plotting on the time-trend graphs. Table 2-3 summarizes the well-parameter combinations for which the trend analysis was performed and time-concentration plots were generated.

The Kendall test for trend evaluates an overall sequence of observations by generating differences between all possible pairs of each observation with previous observations. Differences are assigned as either positive (increasing) or as negative (decreasing), indicating that the latter observation is greater or less than the former observation. The relative magnitude of the difference is not considered; any difference, large or small, is assigned either a positive or negative direction. The Kendall test then assigns probability based on the number of increases given the count of all possible differences, assuming that positive and negative differences are equally likely.

TABLE 2-3
Summary of Time-Concentration Plots Generated and Trend Analyses Performed
Reichhold, Inc., Tacoma, WA

Wells[a]	Indicator constituents								
	Benzene	2,4-Dichlorophenol	Formaldehyde	Molybdenum	Pentachlorophenol	2,3,4,6-Tetrachlorophenol	Trichloroethene	2,4,6-Trichlorophenol	Vinyl chloride
Shallow aquifer									
MW-4(S)	•	•	•	X	•	•	•	•	•
MW-12(S)	•	•	•	X	•	•	•	•	•
MW-14(S)	•	X	X	•	X	X	X	X	X
MW-21(S)2	•	•	X	•	•	•	•	•	•
MW-42(S)2	•	•	•	•	X	•	X	•	•
MW-56(S)	•	•	•	X	•	•	•	•	•
Intermediate aquifer									
MW-7(I)	•	•	X	•	•	•	•	•	•
MW-30(I)	X	•	•	•	X	•	X	X	•
MW-36(I)	•	•	X	•	•	•	•	•	•
MW-39(I)	•	•	X	•	•	•	•	•	•
MW-45(I)	•	•	•	X	•	•	•	•	•
MW-46(I)	•	•	X	•	•	•	•	•	•
MW-48(I)	•	•	•	X	•	•	•	•	•
MW-50(I)	•	•	X	•	•	•	•	•	•
MW-53(I)	•	•	X	X	•	•	•	•	X

[a] CAMP wells with indicator constituent concentrations higher than GWPS during 2001; wells not listed either met the GWPS for the indicator parameters, or were dry, and include MW-1(S), MW-2(S)2, MW-9(S), MW-11(S)2, MW-27(S), MW-33(S), MW-51(S), MW-54(S), MW-57(S), MW-2(I), MW-4(I)2, MW-12(I), MW-16(I), MW-17(I), MW-22(I), MW-28(I), MW-37(I), MW-41(I), and MW-44(I).

• Meets GWPS in 2001.

X Time-concentration plot generated and trend analysis conducted.

Table 2-4 summarizes results of the trend analyses performed on the 27 well-parameter combinations. The table includes the parameter and well identifier, aquifer, and results (p-values) generated from the Kendall test. The results, or p-values, are considered statistically significant if the p-value is less than or equal to 0.05. Table 2-4 presents the statistically significant trends. The direction of the trend is then ascertained based on the direction of the estimated slope; negative slopes indicate decreasing trends, and positive slopes indicate increasing trends.

The Kendall test provides a test of significance for long-term trends and is less sensitive to short-term trends. For example, the test may not indicate a statistically significant trend when the time concentration plot clearly shows a decreasing or increasing trend in the recent sampling events. Therefore, the time concentration plots were evaluated visually in conjunction with the results of the statistical Kendall test.

Sections 2.2.1 and 2.2.2 below summarize the results of the trend analysis and the time-series plots for the shallow and intermediate aquifers. Nineteen of the 27 trend analyses yielded results that were statistically significant. Of the 19 statistically significant trends, 14 were decreasing and five were increasing. Overall, the trend analyses performed indicate that concentrations of most indicator parameters in the shallow and intermediate aquifers are declining in 52 percent of the time series plots and are staying relatively constant in 30 percent of the time series plots. Only about 18 percent of the time trend graphs exhibited a statistically significant increasing concentration trend.

2.2.1 Shallow Aquifer

Six of the 13 shallow aquifer well-parameter combinations included in the Kendall trend analysis exhibited statistically significant trends (Table 2-4). Of these, three were decreasing trends, and three were increasing trends. A statistically significant decreasing trend was exhibited in molybdenum concentrations in MW-56(S). Additionally, both PCP and TCE are decreasing in MW-42(S)2. A statistically significant increasing trend is apparent in 2,4,6-trichlorophenol, TCE, and vinyl chloride in MW-14(S), located adjacent to the former PCP plant in the interior of the facility.

2.2.2 Intermediate Aquifer

Thirteen statistically significant trends were found in the intermediate aquifer well-parameter combinations that were included in the Kendall trend analysis (Table 2-4). Eleven of the 13 statistically significant trends exhibit decreasing concentrations:

- Benzene is decreasing in one well: MW-30(I).
- Formaldehyde is decreasing in six wells: MW-7(I), MW-36(I), MW-39(I), MW-46(I), MW-50(I), and MW-53(I).
- Molybdenum is decreasing in one well: MW-53(I).
- Benzene, PCP, and TCE are decreasing in MW-30(I).

TABLE 2-4
Statistical Trend Analysis Summary, Kendall Test
Reichhold, Inc., Tacoma, WA

Constituent	Shallow aquifer				Intermediate aquifer			
	Well	Result (p-value)[a]	Statistically significant (< 0.05)	Apparent trend direction	Well	Result (p-value)[a]	Statistically significant (< 0.05)	Apparent trend direction
Benzene					MW-30(I)	<0.001	Yes	Decreasing
2,4-Dichlorophenol	MW-14(S)	0.09	No	Decreasing[b]				
Formaldehyde	MW-14(S)	0.25	No	-	MW-7(I)	0.05	Yes	Decreasing
	MW-21(S)2	0.14	No	-	MW-36(I)	0.018	Yes	Decreasing
					MW-39(I)	0.04	Yes	Decreasing
					MW-46(I)	0.02	Yes	Decreasing
					MW-50(I)	0.05	Yes	Decreasing
					MW-53(I)	0.01	Yes	Decreasing
Molybdenum	MW-4(S)	0.81	No	-	MW-45(I)	< 0.001	Yes	Increasing
	MW-12(S)	0.47	No	-	MW-48(I)	0.003	Yes	Increasing[c]
	MW-56(S)	< 0.001	Yes	Decreasing	MW-53(I)	< 0.001	Yes	Decreasing
Pentachlorophenol	MW-14(S)	0.20	No	Decreasing[b]	MW-30(I)	< 0.001	Yes	Decreasing
	MW-42(S)2	< 0.001	Yes	Decreasing				
2,3,4,6-Tetrachlorophenol	MW-14(S)	0.10	No	-				
TCE	MW-14(S)	< 0.001	Yes	Increasing	MW-30(I)	< 0.001	Yes	Decreasing
	MW-42(S)2	0.03	Yes	Decreasing				
2,4,6-Trichlorophenol	MW-14(S)	0.01	Yes	Increasing[d]	MW-30(I)	0.0016	Yes	Decreasing
Vinyl chloride	MW-14(S)	0.03	Yes	Increasing	MW-53(I)	0.07	No	-

[a]A p-value of greater than 0.05 indicates that no statistically significant trend exists.
[b]Trend is not statistically significant under standards of the Kendall test. A decreasing trend since 1999 was noted during visual inspection of trend.
[c]Kendall test indicated an increasing trend but data have been decreasing since 1997 as noted during visual inspection.
[d]Kendall test indicated an increasing trend but data have been decreasing since 1999 as noted during visual inspection.

The two statistically significant increases occur in molybdenum levels. In the case of MW-45(I), the increase is consistent over the period. In the case of MW-48(I), the statistical "increase" is an artifact of the statistical analysis because the time trend plot clearly shows that concentrations have been decreasing since 1997.

SECTION 3

Hydraulic Containment

3.1 Compliance with Hydraulic Performance Standards

Five hydraulic performance standards are specified in Part V.C.(1)(f)(iii) of Reichhold's 1988 permit. Table 3-1 presents these 1988 hydraulic performance standards. It is important to note that these performance standards were developed approximately 14 years ago. Since that time, the hydrogeologic system, including tidal and seasonal effects on groundwater, has been studied extensively at the Reichhold facility. Based on this improved understanding of the groundwater system, more applicable performance standards were proposed in the permit renewal application submitted in 1998.

TABLE 3-1
Hydraulic Performance Standards
Reichhold, Inc., Tacoma, WA

Standard	Description
1	SID maintains a water level lower than the surrounding groundwater table.
2	Shallow aquifer flow lines are converging to the SID from the area beyond the drain and the area internal to the drain.
3	Intermediate aquifer extraction systems are capable of recovering the groundwater both on site and off site, which has been adversely impacted by releases from the facility.
4	Intermediate aquifer groundwater extraction systems are capable of preventing nonpermitted discharges into the Blair Waterway and of reversing the gradient between the Blair Waterway and the off-site extraction system.
5	Groundwater extraction systems are capable of maintaining net groundwater flow from the deep aquifer to the intermediate within the influence of the intermediate groundwater system.

Performance Standards 1 and 2 apply to the shallow aquifer, Performance Standards 3 and 4 apply to the intermediate aquifer, and Performance Standard 5 applies to the inferred flow direction between the intermediate and deep aquifers.

Groundwater levels in shallow aquifer monitoring wells, shallow interceptor drain (SID) piezometers, intermediate aquifer monitoring wells, intermediate aquifer extraction wells, and deep aquifer monitoring wells were measured during the four quarterly monitoring events in 2001 and are summarized in Tables 3-2, 3-3, and 3-4. Figures 3-1 through 3-12 present groundwater contour maps with inferred horizontal groundwater flow direction arrows for the shallow, intermediate, and deep aquifers.

Shallow aquifer contour maps (Figures 3-1 through 3-4) were used to evaluate compliance with Performance Standards 1 and 2; the intermediate aquifer contour maps (Figures 3-5 through 3-8) were used to evaluate compliance with Performance Standards 3 and 4. Figures 3-9 through 3-12 present the deep aquifer contour maps. Intermediate and deep aquifer quarterly groundwater elevations for 2001 are summarized in Tables 3-3 and 3-4,

respectively. The net vertical hydraulic gradients for selected well clusters are presented in Table 3-5 and were used to assess compliance with Performance Standard 5.

TABLE 3-2
2001 Shallow Aquifer Quarterly Groundwater Elevations
Reichhold, Inc. Tacoma, WA

Station	Water elevation in feet (NGVD)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
MW-001(S)	6.76	6.59	6.13	5.41
MW-002(S)2	4.16	4.03	3.68	2.95
MW-003(S)	8.12	7.90	6.74	6.57
MW-004(S)	6.01	5.86	5.06	4.63
MW-005(S)	Dry	Dry	Dry	Dry
MW-006(S)	9.43	8.85	7.27	6.60
MW-008(S)	8.70	8.63	7.48	6.31
MW-009(S)	7.16	7.35	6.01	4.70
MW-010(S)	3.54	3.73	2.70	2.17
MW-011(S)2	6.36	5.57	Dry	Dry
MW-012(S)	7.17	6.24	3.00	2.56
MW-013(S)	3.41	6.46	6.46	5.83
MW-014(S)	6.51	7.20	6.07	5.85
MW-015(S)	8.96	8.63	6.95	5.96
MW-016(S)	7.81	8.10	6.43	5.16
MW-017(S)	5.16	5.32	4.59	4.15
MW-019(S)	7.07	7.64	6.95	7.16
MW-020(S)	8.16	7.49	4.45	3.71
MW-021(S)2	6.50	7.02	5.34	3.24
MW-022(S)	7.01	7.31	5.92	3.76
MW-023(S)2	7.81	7.88	7.03	5.75
MW-024(S)	7.22	7.50	6.94	6.48
MW-025(S)2	7.46	7.03	Dry	Dry
MW-026(S)	8.87	9.22	8.34	7.85
MW-027(S)	6.53	6.73	6.12	5.10
MW-032(S)	9.31	9.00	4.52	2.46
MW-033(S)	3.88	3.92	2.52	Dry
MW-035(S)	2.32	2.32	1.37	1.41
MW-042(S)2	5.61	5.86	4.82	3.79
MW-043(S)	7.54	6.78	4.72	3.26
MW-051(S)	8.71	8.01	5.18	Dry
MW-052(S)	10.27	6.94	6.12	4.88
MW-054(S)	6.60	6.61	5.74	Dry
MW-055(S)	12.76	7.67	Dry	Dry
MW-056(S)	5.12	5.25	4.41	3.21
MW-057(S)	Dry	4.33	Dry	Dry

Station	Water elevation in feet (NGVD)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
MW-058(S)	8.34	8.09	6.96	6.17
PZ3(S)	Dry	Dry	Dry	Dry
PZ4(S)	6.09	6.65	5.09	Dry
PZ5(S)	6.82	7.50	5.78	4.13
PZ6(S)	5.80	6.18	Dry	Dry
PZ7(S)	5.22	5.68	Dry	Dry
SG-01	Not measured[a]	3.05	3.22	3.23
SG-07	Not measured[a]	8.59	Dry	Dry
SG-08	Not measured[a]	Dry	9.03	9.03
SG-09	Not measured[a]	Dry	8.99	8.99
SID-PZ-01	1.21	1.15	1.09	1.07
SID-PZ-02	Dry	4.87	4.76	4.62
SID-PZ-03	Dry	Dry	Dry	Dry
SID-PZ-04	Dry	Dry	Dry	5.46
SID-PZ-05	3.31	3.91	3.57	2.77
SID-PZ-06	1.66	2.96	Dry	1.13
SID-PZ-07	6.21	6.89	4.84	2.88
SID-PZ-08	6.69	7.29	5.45	3.49
SID-PZ-09	Dry	3.96	Dry	Dry
SID-PZ-10	5.37	5.44	4.52	3.45
SID-PZ-11	5.94	5.93	5.59	Dry
SID-PZ-12	4.66	4.56	4.63	Dry
SID-PZ-13	1.82	1.89	2.59	2.40
SID-PZ-14	Dry	Dry	2.49	Dry
SID-PZ-15	3.29	3.35	3.03	2.73

[a]Gauge inaccessible for measurement

TABLE 3-3
2001 Intermediate Aquifer Quarterly Groundwater Elevations
Reichhold, Inc. Tacoma, WA

Station	Water elevation in feet (NGVD)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
MW-001(I)	1.84	2.21	1.21	1.15
MW-002(I)	1.16	1.44	0.67	0.81
MW-003(I)	1.47	1.90	0.77	0.74
MW-004(I)2	1.27	1.47	0.54	0.77
MW-005(I)	2.36	2.22	1.82	1.69
MW-006(I)	1.97	2.30	2.30	1.30
MW-007(I)	2.55	3.06	2.04	1.46
MW-008(I)	0.77	1.70	0.60	-0.05
MW-009(I)	2.53	3.02	2.13	1.45
MW-010(I)	1.07	1.78	1.49	0.28
MW-011(I)2	0.62	1.55	0.29	-0.39
MW-012(I)	3.07	3.41	2.54	1.97
MW-013(I)	2.02	2.31	1.83	1.49
MW-014(I)	1.73	2.35	1.32	0.94
MW-015(I)	2.30	2.82	1.79	1.19
MW-016(I)	3.02	3.43	2.68	2.00
MW-017(I)	2.90	3.31	2.53	2.00
MW-018(I)	2.33	2.75	1.78	1.47
MW-019(I)	1.67	2.39	1.31	0.73
MW-020(I)	1.74	2.43	1.42	0.75
MW-021(I)	2.79	3.21	2.37	1.90
MW-022(I)	3.26	3.58	2.80	2.24
MW-028(I)	1.64	2.33	1.09	0.41
MW-029(I)	1.29	2.03	1.08	0.52
MW-030(I)	0.47	1.27	0.24	-0.34
MW-036(I)	2.26	2.36	1.70	1.39
MW-037(I)	1.47	1.67	0.59	0.94
MW-038(I)	1.85	2.09	1.47	1.39
MW-039(I)	1.95	1.80	1.77	1.36
MW-040(I)	-3.25	-3.90	-4.24	-3.56
MW-041(I)	1.19	1.40	0.79	0.46
MW-044(I)	-1.71	-4.77	-6.07	-2.87
MW-045(I)	-0.45	-1.89	-2.30	-1.21
MW-046(I)	0.98	1.25	0.84	0.33
MW-047(I)	-2.75	-3.94	-3.82	-3.29
MW-048(I)	1.86	2.20	1.17	1.13
MW-050(I)	2.30	2.35	1.96	1.63
MW-053(I)	2.18	2.60	1.65	1.33

Station	Water elevation in feet (NGVD)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
MW-058(I)	2.72	3.22	2.35	1.74
MW-059(I)	1.60	1.97	0.92	0.96
PZ1(I)	0.26	0.56	-0.15	-0.15
PZ2(I)	1.14	1.57	0.33	0.42
EW-1	Not measured[a]	Not measured[a]	Not measured[a]	Not measured[a]
EW-2	Not measured[a]	Not measured[a]	Not measured[a]	Not measured[a]
EW-3	-1.84	-0.66	-2.23	-3.06
EW-4	-16.09	-16.49	-16.19	-15.94
EW-5	-0.30	0.92	-0.48	-1.06
EW-6	-4.44	-3.43	-4.06	-5.28
EW-7	-3.02	-2.10	-5.12	-4.86
EW-8	-2.11	-4.22	-1.49	-7.71
EW-9	-12.51	-11.04	-10.74	-12.44
EW-10	-12.2	-12.08	-12.15	-12.22
Blair Waterway	-1.93	-7.11	-8.77	-3.70

[a]EW-1 and EW-2 are located within 10 feet of intermediate aquifer monitoring wells. Water level data from EW-1 and EW-2 would be redundant.

TABLE 3-4
2001 Deep Aquifer Quarterly Groundwater Elevations
Reichhold, Inc. Tacoma, WA

Station	Water elevation in feet (NGVD)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
MW-001(D)	2.45	2.22	2.14	2.12
MW-004(D)	2.48	2.32	2.16	2.18
MW-007(D)	2.77	2.31	2.23	2.25
MW-010(D)2	2.58	1.63	1.37	2.01
MW-011(D)2	2.49	1.44	1.26	1.91
MW-013(D)	2.44	1.66	1.32	1.90
MW-014(D)	2.43	2.16	2.07	2.18
MW-022(D)	2.83	2.42	2.34	2.41
MW-040(D)	1.58	0.82	0.28	2.23
MW-049(D)	2.42	2.32	2.43	2.12
MW-053(D)	2.36	2.15	2.02	2.06
MW-060(D)	2.53	1.97	1.79	2.18

TABLE 3-5
2001Vertical Groundwater Flow Directions Between the Intermediate/Deep Aquifer Well Clusters
Reichhold, Inc., Tacoma

Monitoring well cluster	Approx-imate tide time lag (hours)	Vertical distance between screened zones (feet)	January 30, 2001		April 26, 2001		July 20, 2001		October 16, 2001		Annual net gradient[h]	Annual net flow direction
			Water level elevation[d] (feet NGVD)	Vertical gradient[h]	Water level elevation[e] (feet NGVD)	Vertical gradient[h]	Water level elevation[f] (feet NGVD)	Vertical gradient[h]	Water level elevation[g] (feet NGVD)	Vertical gradient[h]		
MW-1(I)	4.5[a]	32.5	1.80		2.16		1.26		1.18			
MW-1(D)			2.27	+0.014	2.26	+0.003	2.23	+0.030	1.66	+0.015	+0.016	Upward
MW-4(I)2	2.5[b]	22.0	1.31		1.45		0.54		0.75			
MW-4(D)			2.20	+0.040	1.70	+0.011	2.16	+0.074	1.83	+0.049	+0.044	Upward
MW-10(I)	2.5[b]	31.3	1.08		1.83		0.77		0.27			
MW-10(D)2			2.19	+0.035	2.28	+0.014	2.16	+0.044	1.55	+0.041	+0.034	Upward
MW-11(I)2	2.5[b]	27.0	0.57		1.26		0.19		-0.52			
MW-11(D)2			2.11	+0.057	1.27	+0.000	2.08	+0.070	1.50	+0.075	+0.051	Upward
MW-13(I)	2.5[b]	20.9	1.85		2.30		2.05		1.56			
MW-13(D)			2.30	+0.022	2.22	-0.004	2.22	+0.008	2.16	+0.029	+0.014	Upward
MW-40(I)	negligible[c]	18.0	-3.25		-3.90		-4.24		-3.56			
MW-40(D)			1.58	+0.268	0.82	+0.262	0.28	+0.251	2.23	+0.322	+0.276	Upward

[a]Based on the *Preclosure Investigation and Hydrogeologic Assessment Report* (CH2M HILL, 1987) and confirmed with field measurements.

[b]Based on field measurements.

[c]Tidal time-lag negligible at this location because of its proximity to the Blair Waterway.

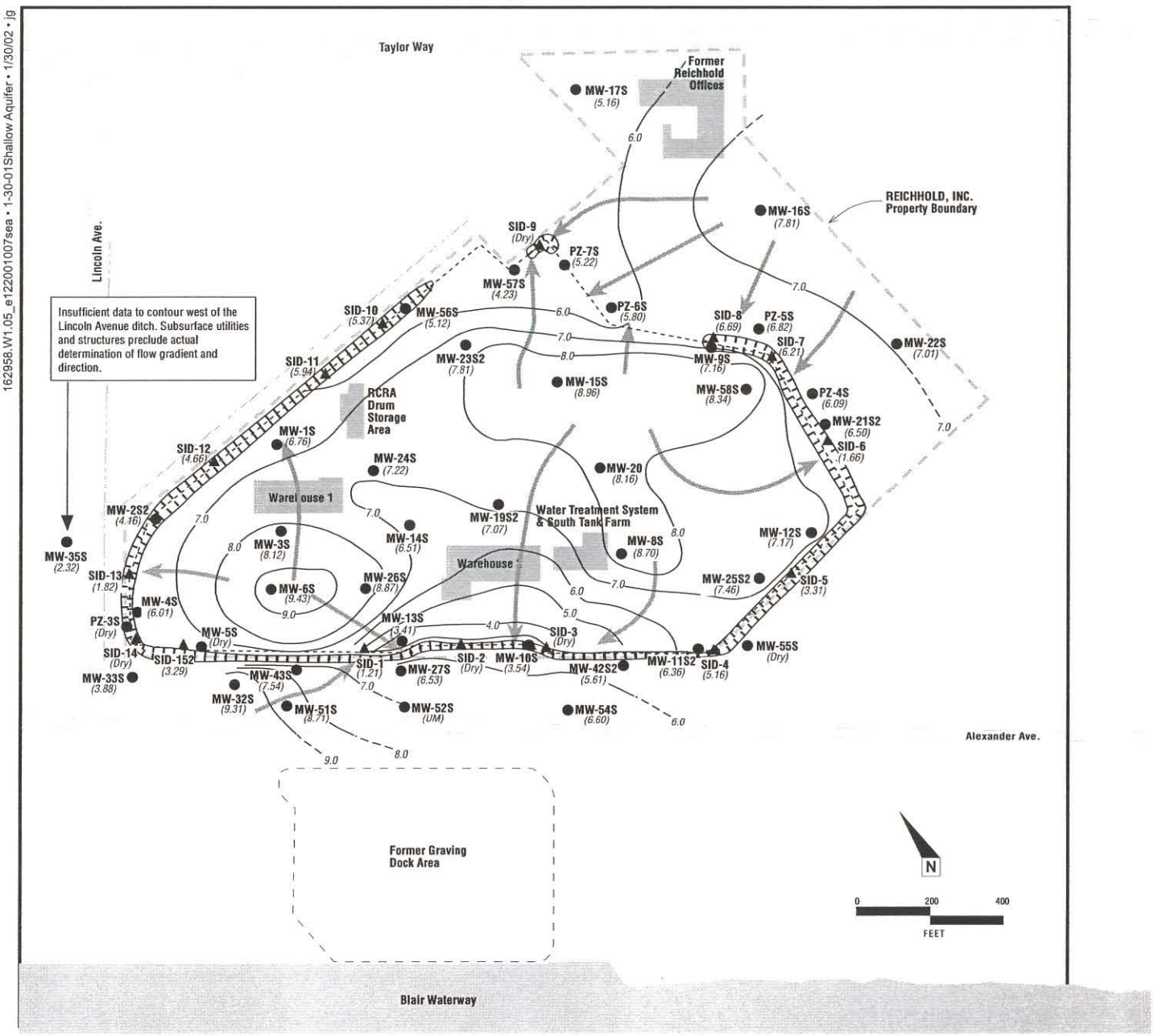
[d]Datalogger data from low high tide on January 13, 2001 to low high tide on February 2, 2001 for MW-1 and MW-13 well clusters.

[e]Datalogger data from high high tide April 26, 2001 to high high tide April 30, 2001 used for MW-1 and MW-13 well clusters.

[f]Datalogger data from high high tide July 20, 2001 to high high tide July 23, 2001 used for the MW-1 and MW-13 well clusters; datalogger data from high high tide on July 24, 2001 to high high tide on July 25, 2001 used for the MW-10 and MW-11 well clusters.

[g]Datalogger data from high high tide October 16, 2001 to high high tide October 18, 2001 used for the MW-1 and MW-13 well clusters.

[h]Positive value indicates upward flow direction, and negative value indicates downward flow direction.



KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- Shallow Interceptor Drain (SID)
- ▲ SID-1 SID Piezometer
- 3.0 Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 1.0 foot

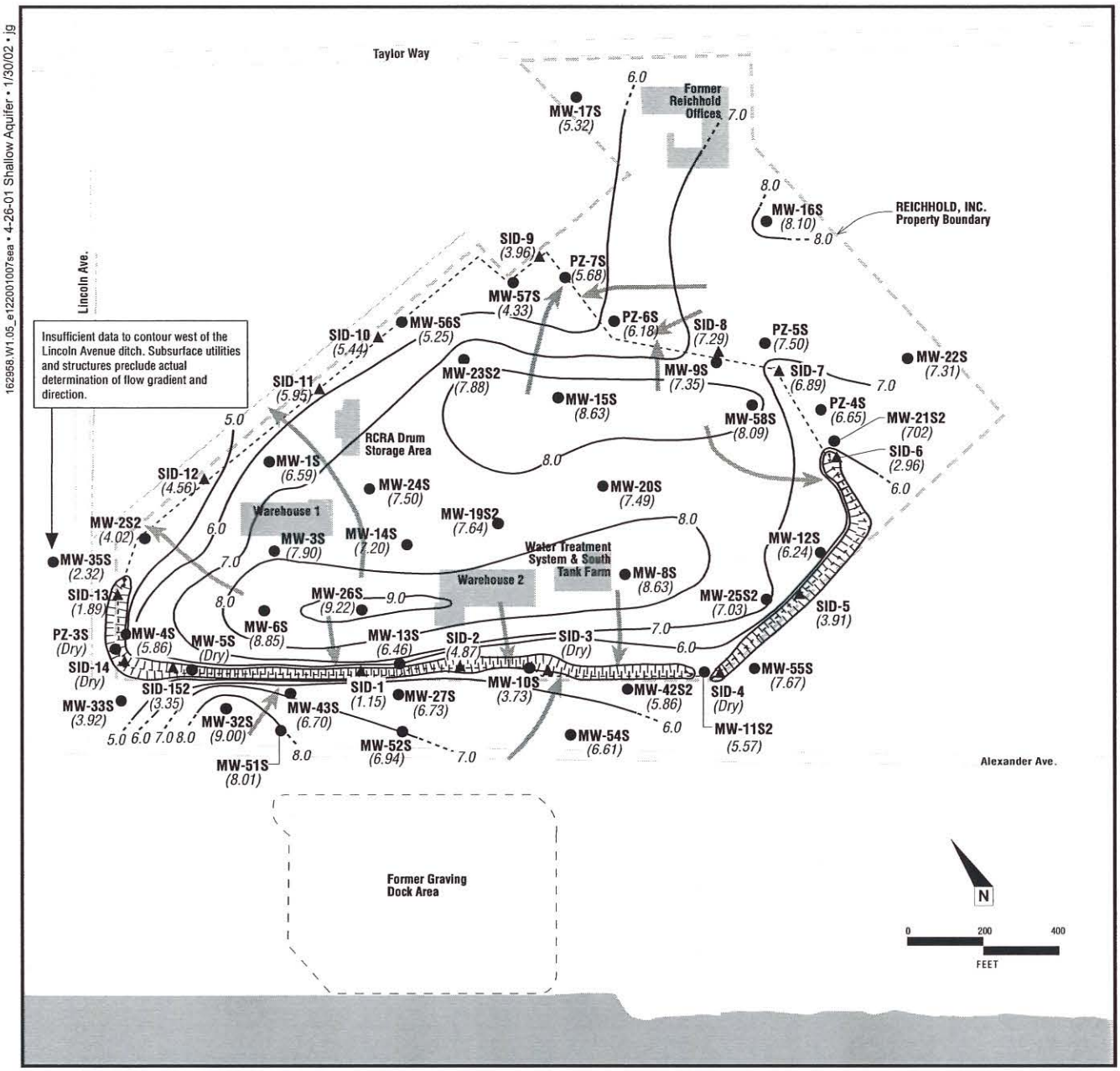
Tide Table for January 30, 2001

Low Low Tide Time: 0209 Elevation (NGVD): -4.0	**High Low Tide** **Time: 1527** **Elevation (NGVD): -2.6**
Low High Tide Time: 2103 Elevation (NGVD): 2.3	High High Tide Time: 0853 Elevation (NGVD): 5.8

Time Range for Water Level Measurements = 1246 to 1404

Figure 3-1
Groundwater Contour Map
Shallow Aquifer
January 30, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- Shallow Interceptor Drain (SID)
- ▲ SID-1 SID Piezometer
- 3.0 Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 1.0 foot

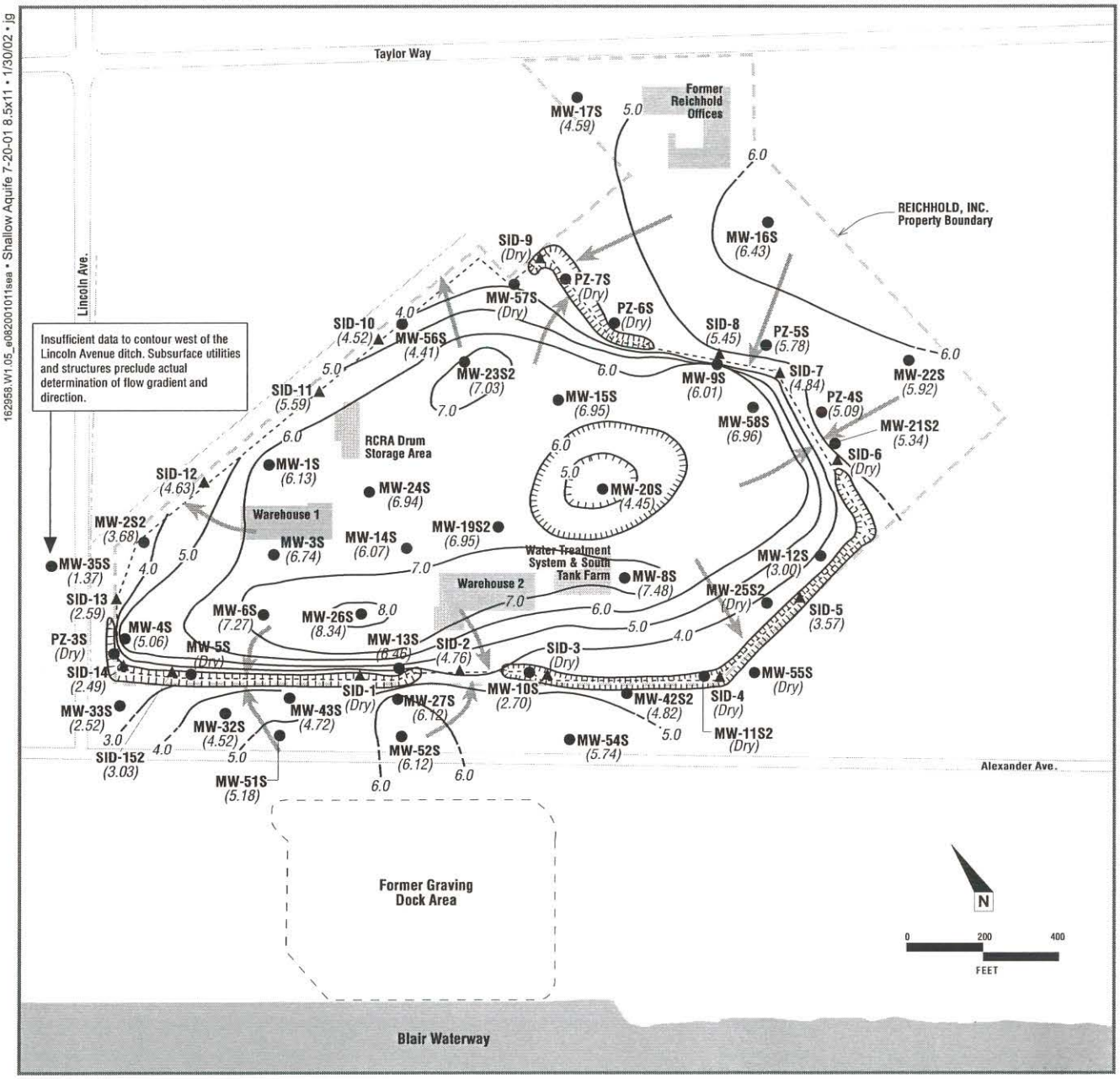
Tide Table for April 26, 2001

Low Low Tide **Time: 1346** **Elevation (NGVD): -8.0**	High Low Tide Time: 0131 Elevation (NGVD): -0.8
Low High Tide Time: 0641 Elevation (NGVD): 4.7	High High Tide Time: 2053 Elevation (NGVD): 5.3

Time Range for Water Level Measurements = 0938 to 1106

Figure 3-2
Groundwater Contour Map Shallow Aquifer
April 26, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- Shallow Interceptor Drain (SID)
- ▲ SID-1 SID Piezometer
- 3.0 Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 1.0 foot

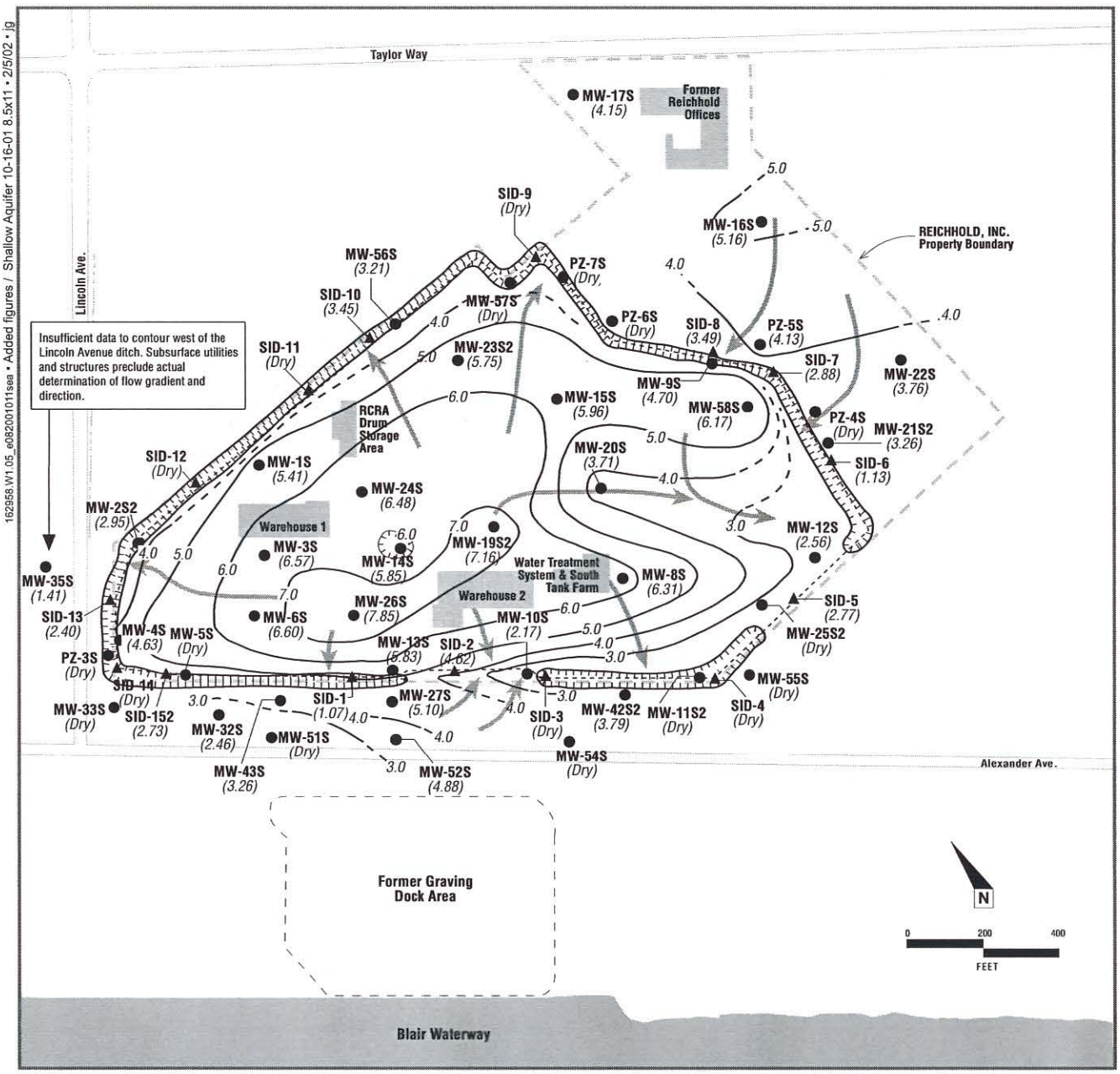
Tide Table for July 20, 2001

Low Low Tide **Time: 1121** **Elevation (NGVD): -9.7**	High Low Tide Time: – Elevation (NGVD): –
Low High Tide Time: 0352 Elevation (NGVD): 5.0	High High Tide Time: 1851 Elevation (NGVD): 6.1

Time Range for Water Level Measurements = 0919 to 1112

Figure 3-3
Groundwater Contour Map
Shallow Aquifer
July 20, 2001

Reichhold, Inc., Tacoma, WA



162958.W1.05_e082001011sea • Added figures / Shallow Aquifer 10-16-01 8.5x11 • 2/5/02 • jg

KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- Shallow Interceptor Drain (SID)
- ▲ SID-1 SID Piezometer
- 3.0 Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 1.0 foot

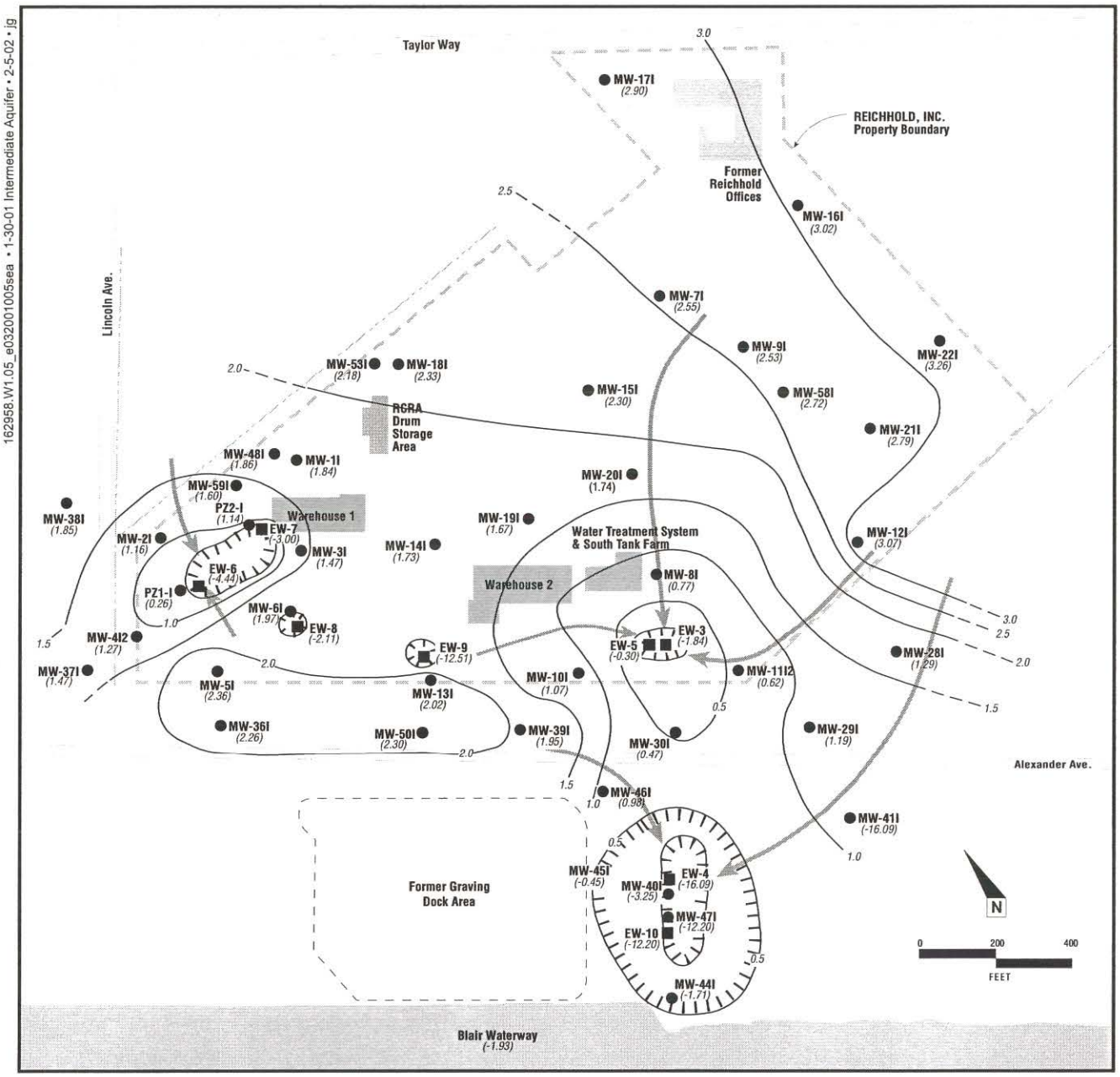
Tide Table for October 16, 2001

Low Low Tide Time: 2346 Elevation (NGVD): -6.7	**High Low Tide** **Time: 1112** **Elevation (NGVD): -4.4**
Low High Tide Time: 0514 Elevation (NGVD): 4.8	High High Tide Time: 1718 Elevation (NGVD): 6.0

Time Range for Water Level Measurements = 0838 to 0940

Figure 3-4
Groundwater Contour Map
Shallow Aquifer
October 16, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- EW-1 — Extraction well
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 0.5 foot

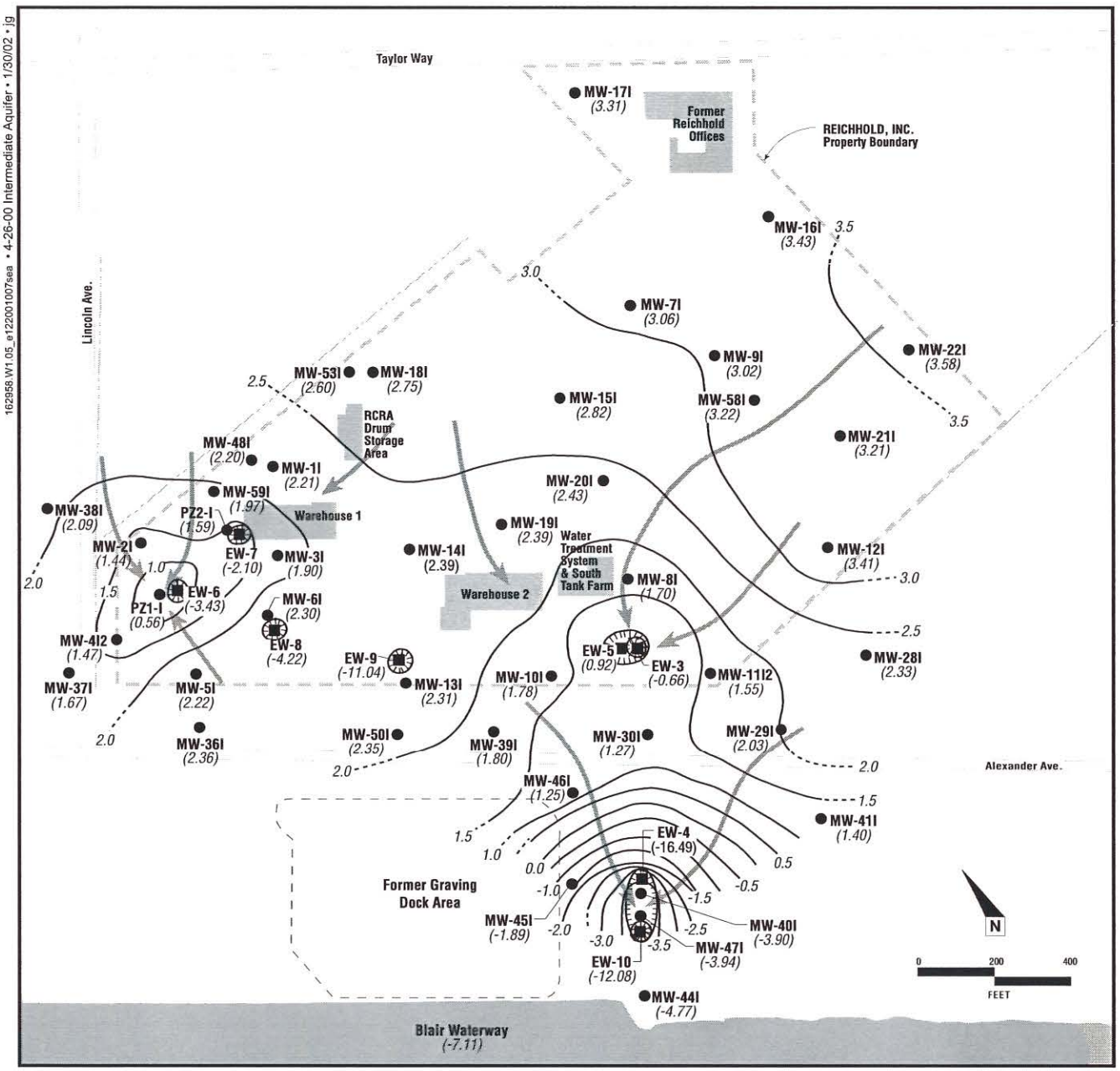
Tide Table for January 30, 2001

Low Low Tide Time: 0209 Elevation (NGVD): -4.0	**High Low Tide** **Time: 1527** **Elevation (NGVD): -2.6**
Low High Tide Time: 2103 Elevation (NGVD): 2.3	High High Tide Time: 0859 Elevation (NGVD): 5.8

Time Range for Water Level Measurements = 1309 to 1556

Figure 3-5
Groundwater Contour Map
Intermediate Aquifer
January 30, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-56S
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- EW-1 — Extraction well
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 0.5 foot

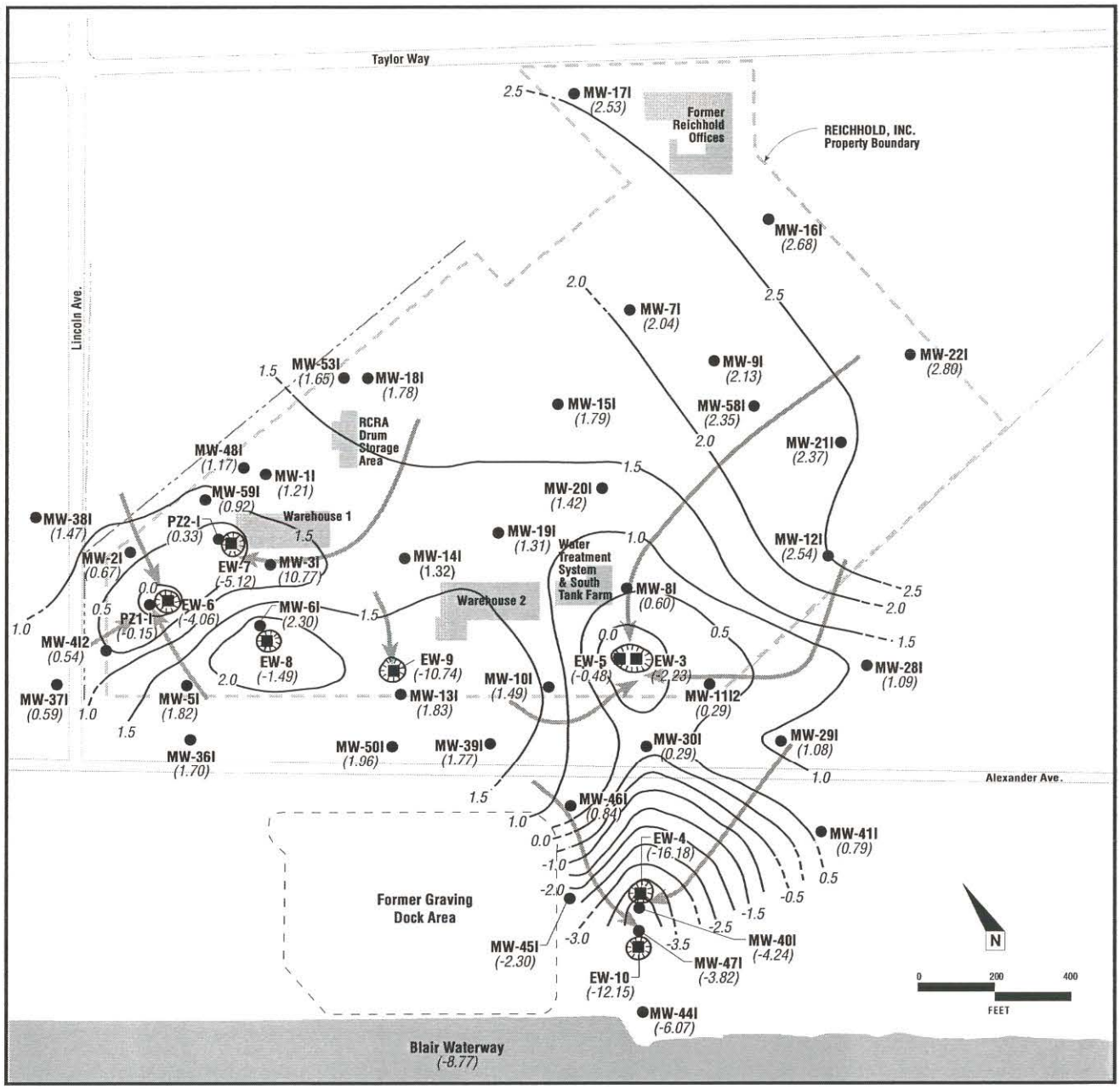
Tide Table for April 26, 2001

Low Low Tide	High Low Tide
Time: 1346	Time: 0131
Elevation (NGVD): -8.0	Elevation (NGVD): -0.8
Low High Tide	High High Tide
Time: 0641	Time: 2053
Elevation (NGVD): 4.7	Elevation (NGVD): 5.3

Time Range for Water Level Measurements = 1301 to 1403

Figure 3-6
Groundwater Contour Map
Intermediate Aquifer
April 26, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-58I
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- EW-1 — Extraction well
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 0.5 foot

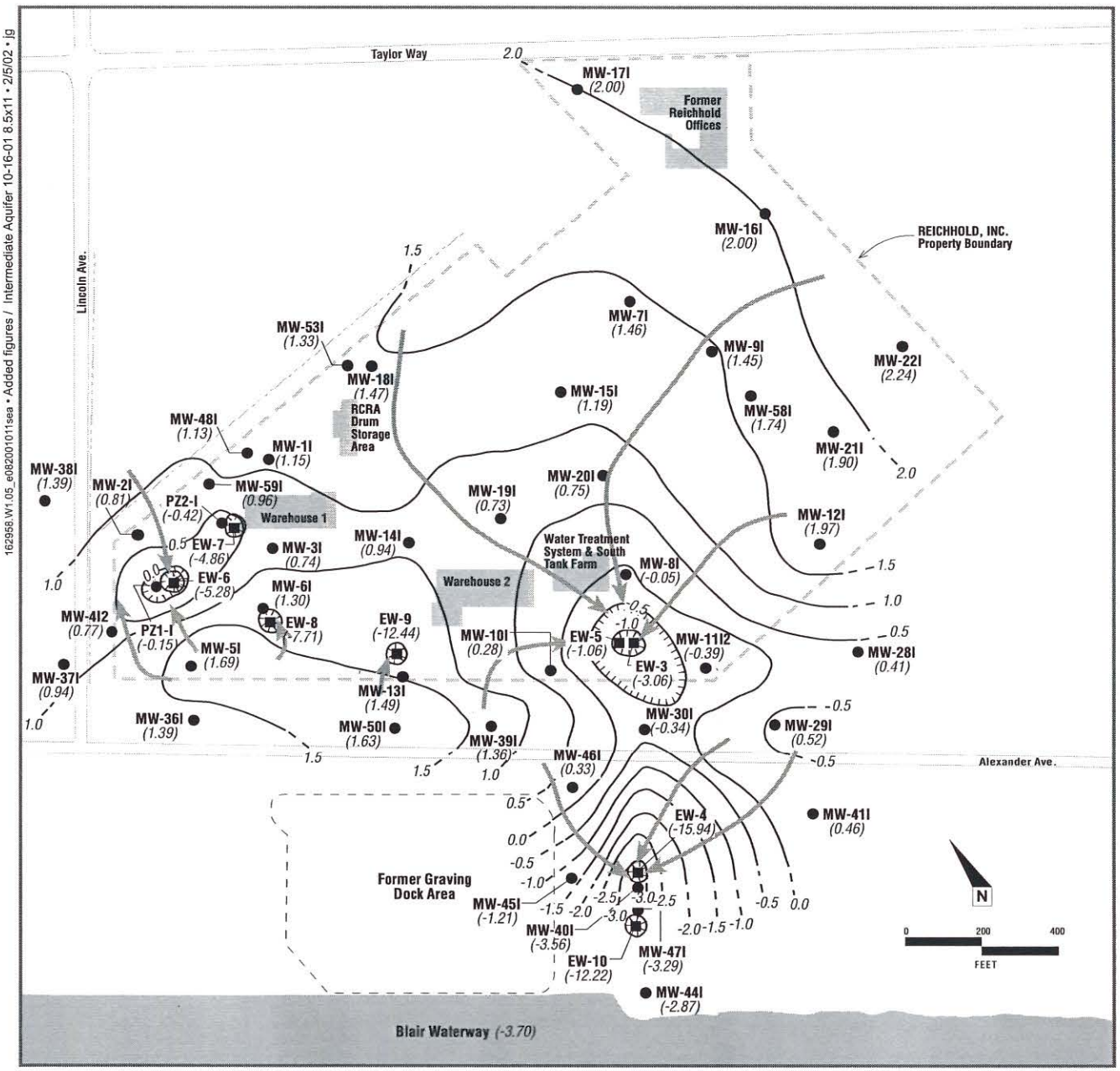
Tide Table for July 20, 2001

Low Low Tide **Time: 1121** **Elevation (NGVD): -9.7**	High Low Tide Time: – Elevation (NGVD): –
Low High Tide Time: 0352 Elevation (NGVD): 5.0	High High Tide Time: 1851 Elevation (NGVD): 6.1

Time Range for Water Level Measurements = 1036 to 1135

Figure 3-7
Groundwater Contour Map
Intermediate Aquifer
July 20, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-58I
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- EW-1 — Extraction well
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction
- Groundwater depression

Contour interval equals 0.5 foot

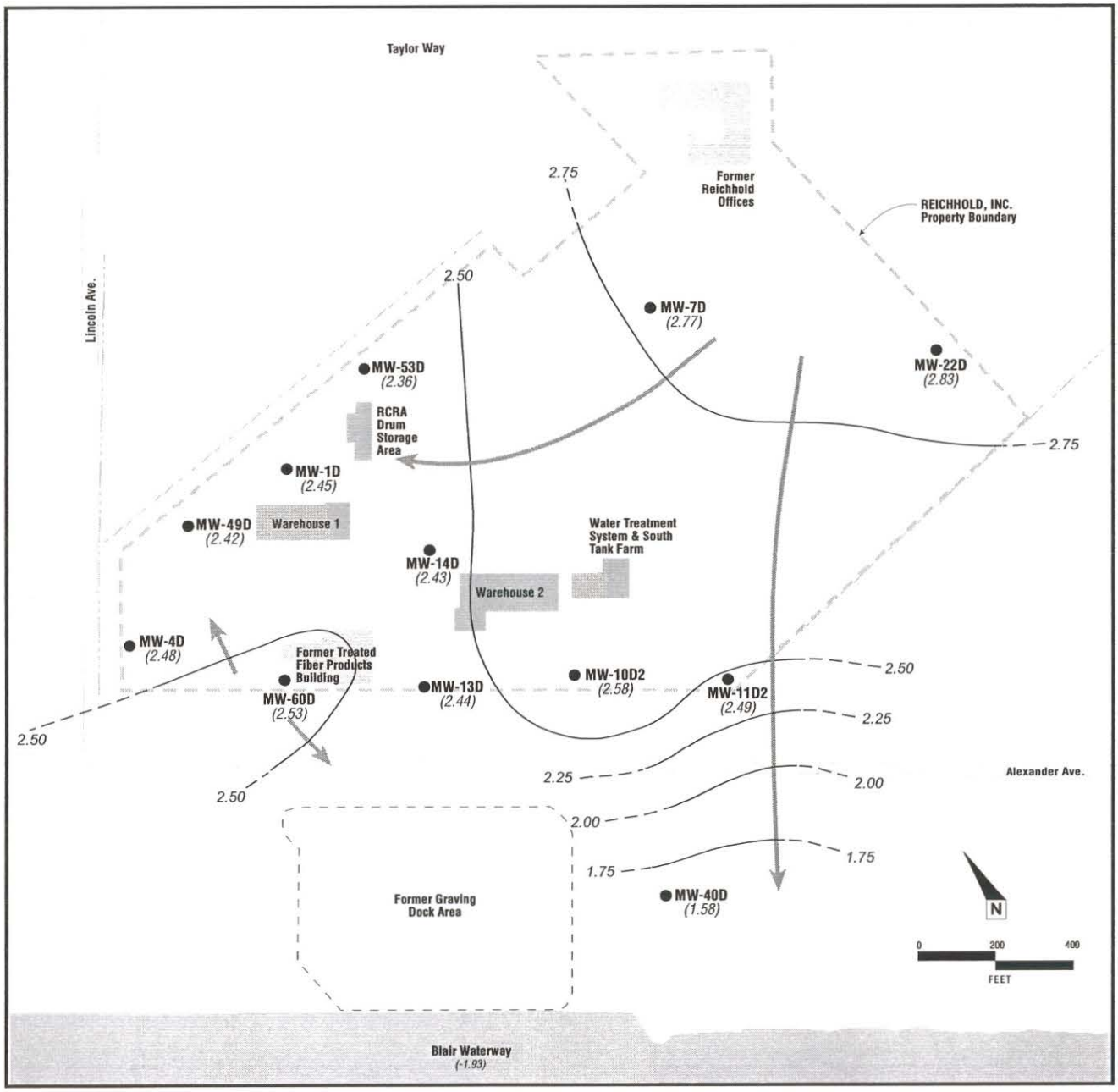
Tide Table for October 16, 2001

Low Low Tide Time: 2346 Elevation (NGVD): -6.7	**High Low Tide** **Time: 1112** **Elevation (NGVD): -4.4**
Low High Tide Time: 0514 Elevation (NGVD): 4.8	High High Tide Time: 1718 Elevation (NGVD): 6.0

Time Range for Water Level Measurements = 1027 to 1138

Figure 3-8
Groundwater Contour Map
Intermediate Aquifer
October 16, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-53D
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction

Contour interval equals 0.25 foot

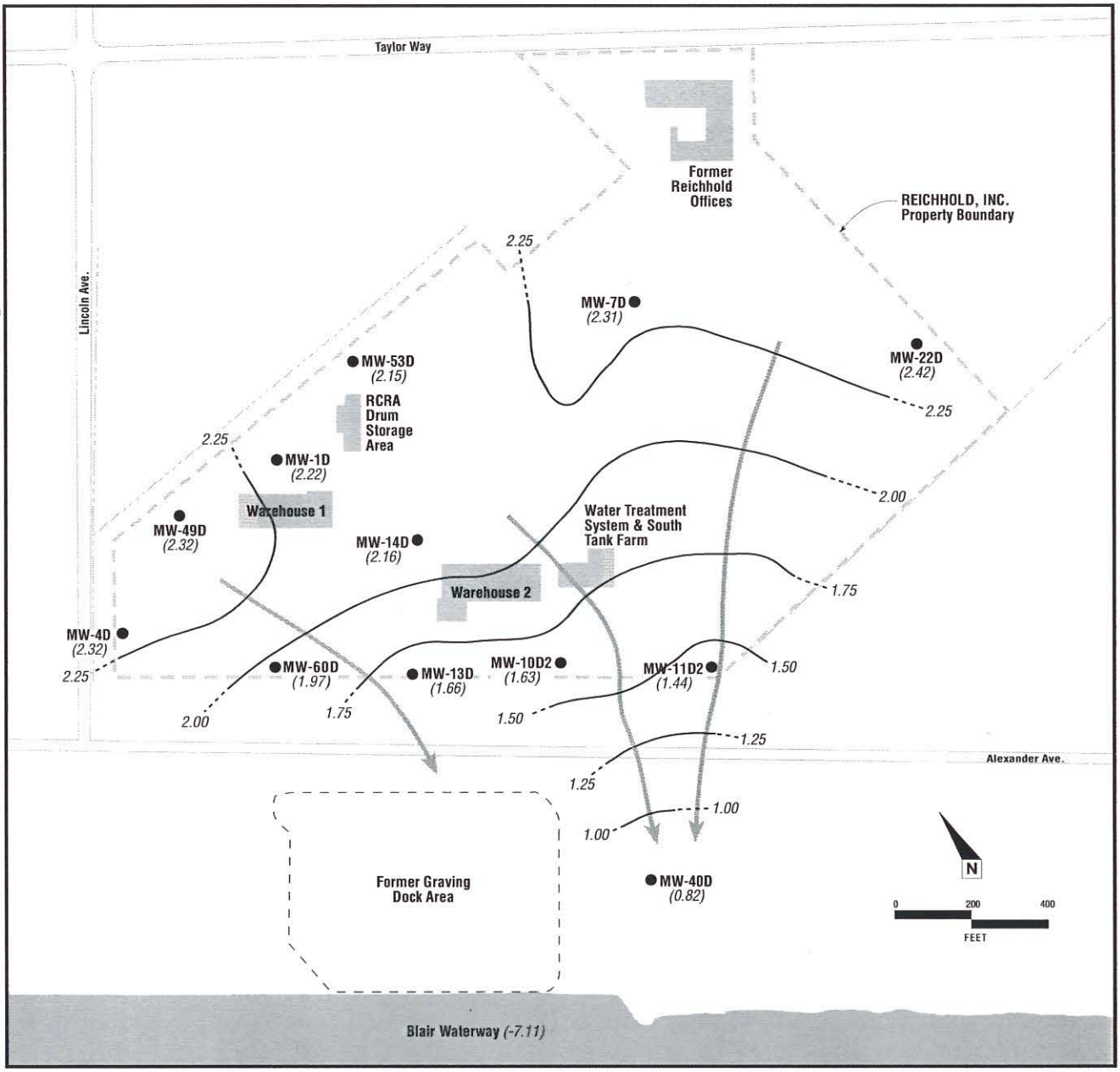
Tide Table for January 30, 2001

Low Low Tide Time: 0209 Elevation (NGVD):	**High Low Tide** **Time: 1527** **Elevation (NGVD): -2.6**
Low High Tide Time: 2103 Elevation (NGVD): 2.3	High High Tide Time: 0859 Elevation (NGVD): 5.8

Time Range for Water Level Measurements = 1444 to 1553

Figure 3-9
Groundwater Contour Map
Deep Aquifer
January 30, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-53D
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction

Contour interval equals 0.25 foot

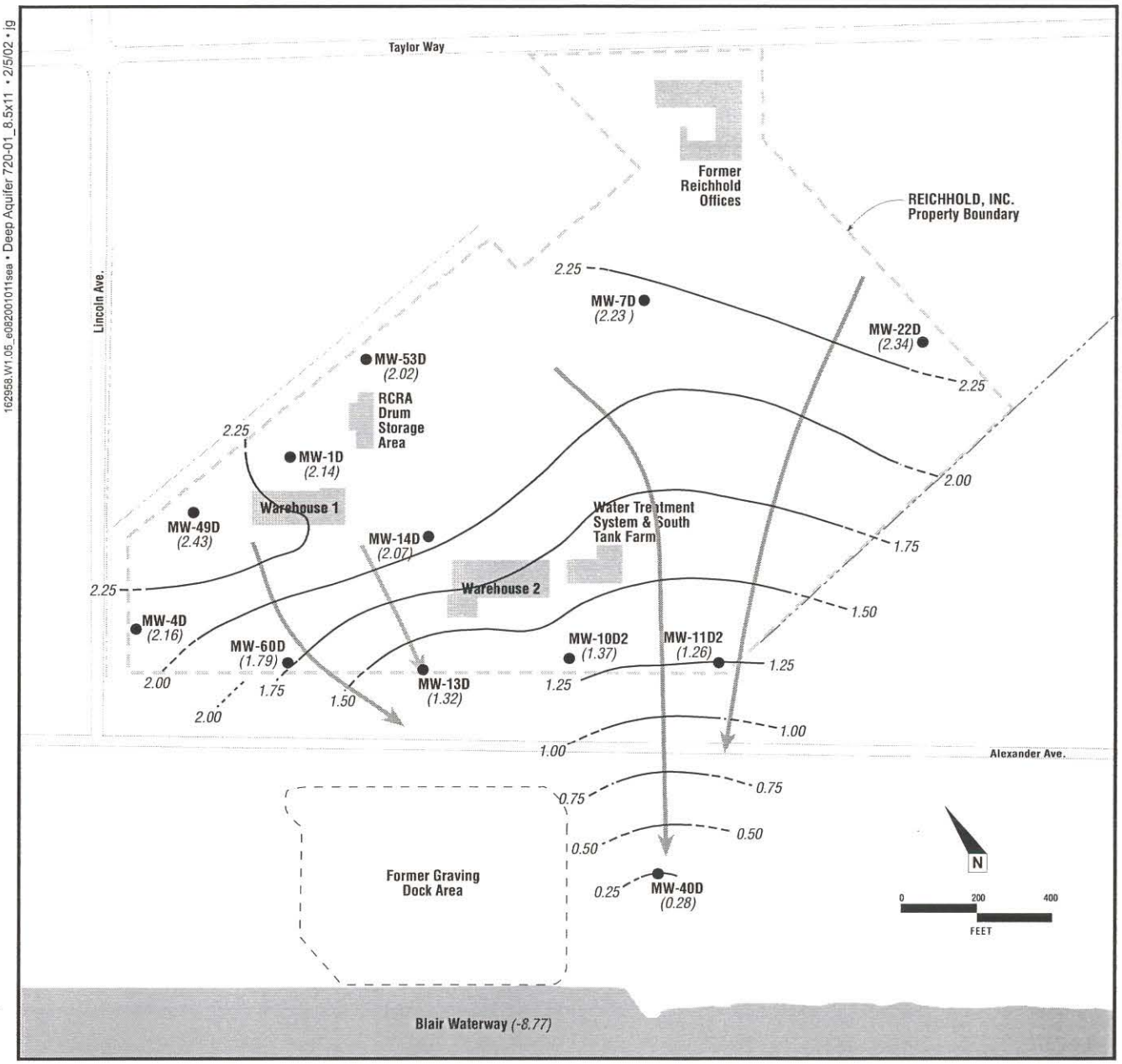
Tide Table for April 26, 2001

Low Low Tide **Time: 1346** **Elevation (NGVD): -8.0**	High Low Tide Time: 0131 Elevation (NGVD): -0.8
Low High Tide Time: 0641 Elevation (NGVD): 4.7	High High Tide Time: 2053 Elevation (NGVD): 5.3

Time Range for Water Level Measurements = 1301 to 1400

Figure 3-10
Groundwater Contour Map
Deep Aquifer
April 26, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-53D
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction

Contour interval equals 0.25 foot

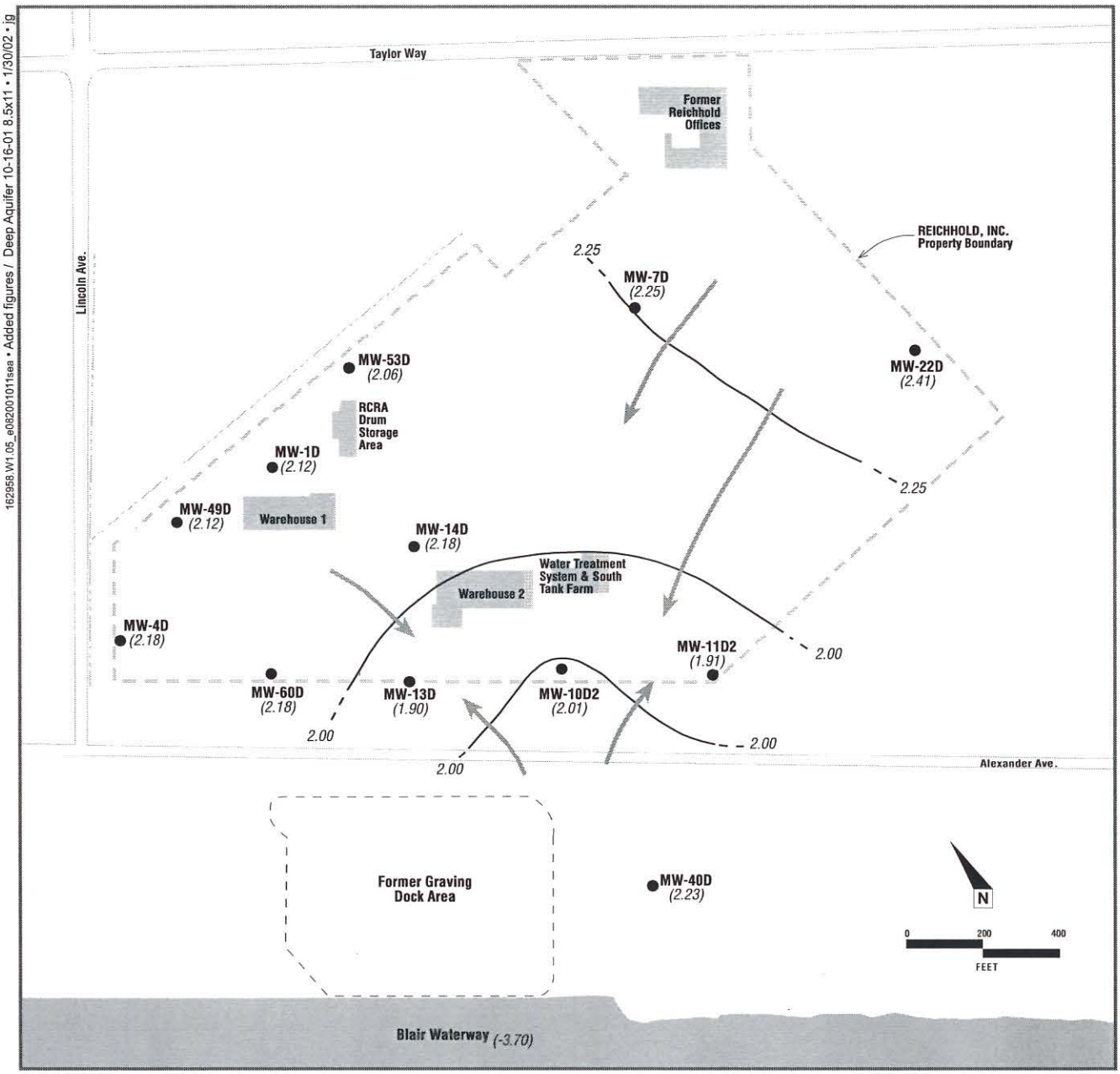
Tide Table for July 20, 2001

Low Low Tide **Time: 1121** **Elevation (NGVD): -9.7**	High Low Tide Time: – Elevation (NGVD): –
Low High Tide Time: 0352 Elevation (NGVD): 5.0	High High Tide Time: 1851 Elevation (NGVD): 6.1

Time Range for Water Level Measurements = 1039 to 1129

Figure 3-11
Groundwater Contour Map
Deep Aquifer
July 20, 2001

Reichhold, Inc., Tacoma, WA



KEY

- MW-53D
  - Aquifer monitored
  - Well number
  - Well location
- Property boundary
- Ditch
- 3.0 — Approximate location of potentiometric surface contour (dashed where inferred)
- Inferred groundwater flow direction

Contour interval equals 0.25 foot

Tide Table for October 16, 2001

Low Low Tide Time: 2346 Elevation (NGVD): -6.7	**High Low Tide** **Time: 1112** **Elevation (NGVD): -4.4**
Low High Tide Time: 0514 Elevation (NGVD): 4.8	High High Tide Time: 1718 Elevation (NGVD): 6.0

Time Range for Water Level Measurements = 1029 to 1129

Figure 3-12
Groundwater Contour Map
Deep Aquifer
October 16, 2001

Reichhold, Inc., Tacoma, WA

3.1.1 Performance Standard 1

Performance Standard 1 requires that "shallow interceptor drain maintains a water level lower than the surrounding groundwater table." The intent of Performance Standard 1 is to prevent off-site migration of shallow aquifer groundwater containing constituent concentrations above the GWPS. This intent was met every quarter in 2001 (see Figures 3-1 through 3-4). In some areas, however, transient on-site flow occurred, as evidenced by groundwater levels in the SID being higher than nearby on-site monitoring wells. The following were these situations:

- During all four quarters of 2001, the water level elevation in SID-10 was higher than in nearby on-site MW-56(S). Both SID-10 and MW-56(S) are located along a segment of the SID that extends from SID-9 to SID-11. The low point of this SID segment is at the sump east of MW-56(S). With the SID working as intended, shallow groundwater flow directions are generally toward the SID, with a downgradient component toward the sump east of MW-56(S). SID-10 is located west and upgradient of MW-56(S) relative to the sump. The lower water-level elevation measured in MW-56(S) is expected to be influenced by the low water level in the nearby SID sump. The higher water levels at SID-10 are not unexpected and our professional interpretation of groundwater flow directions in the area indicate that hydraulic containment was achieved during all four quarters of 2001.
- In July and October, the water-level elevation in SID-5 was higher than in nearby MW-12(S); however, MW-25(S)2 is closer to SID-5 and was dry. MW-55(S), located outside the SID, was also dry, indicating no water movement across the SID in that area.

3.1.2 Performance Standard 2

Performance Standard 2 requires that "shallow aquifer flow lines are converging to the interceptor drain from the area beyond the drain and the area internal to the drain." The intent of Performance Standard 2 is for the SID to capture potentially contaminated shallow aquifer groundwater from the site and from the area surrounding the site. Compliance with Performance Standard 2 was demonstrated during all four quarters of 2001 (Figures 3-1 through 3-4).

3.1.3 Performance Standard 3

Performance Standard 3 specifies that the intermediate aquifer groundwater extraction systems are "capable of recovering the groundwater both on site and off site, which has been adversely impacted by the releases from the facility." The intent of hydraulic Performance Standard 3 is for the intermediate aquifer groundwater extraction systems to capture and recover contaminated groundwater in the intermediate aquifer.

Performance Standard 3 was met during all four quarters of 2001. As shown in Figures 3-5 through 3-8, intermediate aquifer groundwater from on site and from the off-site area north and south of Alexander Avenue was recovered by extraction wells EW-3, EW-4, EW-5, EW-6, EW-7, EW-8, EW-9, and EW-10 during the water-level monitoring conducted during all four quarters of 2001.

3.1.4 Performance Standard 4

Performance Standard 4 requires that the groundwater extraction systems be "capable of preventing nonpermitted discharges in the Blair Waterway and of reversing the gradient between the Blair Waterway and the off-site extraction system." The intent of hydraulic Performance Standard 4 is for off-site extraction wells EW-4 and EW-10 to maintain a groundwater gradient direction toward the extraction system and prevent contaminated groundwater from entering Blair Waterway.

Performance Standard 4 was met during all four quarters of 2001. Groundwater contour maps (Figures 3-5 through 3-8) show that inferred groundwater flow directions in the off-site area are toward the extraction well system (EW-4 and EW-10). This indicates that the off-site extraction well system is capable of reversing the gradient and preventing nonpermitted releases to Blair Waterway, demonstrating compliance with Performance Standard 4.

During the summer of 1995, the Port of Tacoma dredged Blair Waterway and cut the bank back approximately 80 feet. Because MW-44(I) is close to the current bank of the Blair Waterway, EPA considers MW-44(I) to no longer be a valid monitoring point for evaluating compliance with hydraulic Performance Standard 4 (Bartus, 1995). Therefore, a compliance evaluation with Performance Standard 4 was made by assessing the groundwater gradient between EW-10 and the Blair Waterway.

3.1.5 Performance Standard 5

Performance Standard 5 requires that the groundwater extraction system be capable of maintaining net groundwater flow from the deep aquifer to the intermediate aquifer within the influence of the intermediate groundwater system. Compliance with this standard is demonstrated by documenting upward vertical groundwater flow that occurred across the confining layer separating the intermediate and deep aquifers during 2001.

The confining layer has the following physical properties, as noted in the Revised RCRA Part B Permit Application (CH2M HILL, 1988):

- Thickness: 12 to 15 feet
- Vertical hydraulic conductivity: 0.0002 to 0.005 foot per day (ft/d)
- Effective porosity: 0.2

The low vertical hydraulic conductivity of the confining layer causes the rate of groundwater movement across this layer to be negligible. For this reason, average vertical gradient directions that occur over a longer time period—on the order of several years—will determine the net groundwater flow across the confining layer (both direction and rate).

Table 3-5 documents that the net vertical flow direction between the intermediate and deep aquifers at the site was upward in 2001 at all six of the six monitored well clusters. A transient downward vertical flow direction occurred at one well cluster, MW-13 during the April 2001 quarterly monitoring event only. The vertical flow direction was upward during the remaining three quarters of 2001, and the net direction was upward for the year.

3.2 Horizontal Hydraulic Gradients and Groundwater Flow Velocities

Horizontal hydraulic gradients and flow velocities are provided in this section as required in Part V.C. (1)(b)(ii) of the permit. Hydraulic gradients for the shallow, intermediate, and deep aquifers were estimated using groundwater elevation contours maps (Figures 3-1 through 3-12). Linear groundwater flow velocities based on groundwater elevation contours from the quarterly water level monitoring events in 2001 were estimated using a modified form of Darcy's Law:

$$V = (K)(i)/n$$

Where:

V	=	linear velocity (ft/d)
K	=	hydraulic conductivity (ft/d)
i	=	hydraulic gradient (feet per foot, or ft/ft)
n	=	effective porosity (volume per volume)

Hydraulic gradients and groundwater flow velocities for the shallow, intermediate, and deep aquifers are presented below.

3.2.1 Shallow Aquifer

Table 3-6 presents the hydraulic gradient estimates for the shallow aquifer based on inferred flow lines and groundwater elevation contours (Figures 3-1 through 3-4). Estimated average horizontal hydraulic gradients in the shallow aquifer ranged from 0.004 to 0.029.

For estimating groundwater flow velocities, the hydraulic conductivity range of values used for the shallow aquifer (0.2 ft/d to 17.0 ft/d) was based on data from the 1987 *Preclosure Investigation and Hydrogeologic Assessment Report* (CH2M HILL, 1987). The assumed effective porosity of the shallow aquifer is 0.2, based on soil classifications obtained from samples obtained during well installation.

As summarized in Table 3-7, estimated minimum groundwater flow velocities in the shallow aquifer ranged from less than 0.01 ft/d to 0.03 ft/d, and estimated maximum velocities ranged from 0.34 ft/d to 2.47 ft/d.

3.2.2 Intermediate Aquifer

Horizontal hydraulic gradients for the intermediate aquifer, presented in Table 3-8, were estimated using inferred flow lines and groundwater elevation contours (Figures 3-5 through 3-8). The highest calculated groundwater gradients in the intermediate aquifer were toward off-site extraction wells EW-4 and EW-10. The flattest measured gradients were towards EW-3 and EW-5. These wells are good producers but are located in a more permeable area of the intermediate aquifer. The cones of depression associated with these two wells tend to propagate farther laterally than other extraction well pairs. EW-8 and EW-9 do not produce sufficient yields for sustained pumping and, therefore, develop smaller cones of depression that are too small to be measurable at the scale of the contour maps.

Calculated average groundwater gradients in the intermediate aquifer ranged from 0.002 to 0.010.

The intermediate aquifer hydraulic conductivity values from the 1989 pumping test results from extraction wells EW-3, EW-4, EW-5, and EW-7 were used for estimating groundwater flow velocities. These hydraulic conductivity values are presented in *Extraction Well Startup Testing Summary-1990* (CH2M HILL, 1990). The specific hydraulic conductivity value associated with each extraction well cluster was used for groundwater velocity calculations. The assumed effective porosity of the intermediate aquifer is 0.2 based on soil classifications from samples obtained during well installation.

TABLE 3-6
Shallow Aquifer Hydraulic Gradient Estimates[a]
Reichhold, Inc., Tacoma, WA

Measurement location	Average horizontal hydraulic gradient (ft/ft)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
Northern section of SID[b] (interior)	0.014	0.014	0.015	0.011
Eastern section of SID[c] (interior)	0.025	0.013	0.029	0.018
Eastern section of SID[c] (exterior)	0.004	0.006	0.006	0.004
Southern section of SID[d] (interior)	0.021	0.024	0.023	0.022
Southern section of SID[d] (exterior)	0.010	0.018	0.010	Not measurable[e]

[a]Hydraulic gradients estimated from 2001 shallow aquifer groundwater contour maps (Figures 3-1 through 3-4).
[b]Includes the area from SID-PZ-09 westward to SID-PZ-14.
[c]Includes the area from SID-PZ- 05 northward to SID-PZ-09.
[d]Includes the area from SID-PZ-15 eastward to SID-PZ-05.
[e]Insufficient contours to evaluate gradients in this area.

TABLE 3-7
Shallow Aquifer Groundwater Flow Velocity Estimates
Reichhold, Inc., Tacoma, WA

Measurement location	Linear velocity (ft/d)							
	January 30, 2001		April 26, 2001		July 20, 2001		October 16, 2001	
	Min[a]	Max[b]	Min[a]	Max[b]	Min[a]	Max[b]	Min[a]	Max[b]
Northern section of SID (interior)	0.01	1.19	0.01	1.19	0.02	1.28	0.01	0.94
Eastern section of SID (interior)	0.03	2.13	0.01	1.11	0.03	2.47	0.02	1.53
Eastern section of SID (exterior)	<0.01	0.34	0.01	0.51	0.01	0.51	<0.01	0.34
Southern section of SID (interior)	0.02	1.79	0.02	2.04	0.02	1.96	0.02	1.87
Southern section of SID (exterior)	0.01	0.85	0.02	1.53	0.01	0.85	NA[c]	NA[c]

[a]Estimated using hydraulic conductivity of 0.2 ft/d and hydraulic gradients from Table 3-6.
[b]Estimated using hydraulic conductivity of 17 ft/d and hydraulic gradients from Table 3-6.
[c]NA Not analyzed because hydraulic gradient data for that area are not available.

TABLE 3-8
Intermediate Aquifer Hydraulic Gradient Estimates[a]
Reichhold, Inc., Tacoma, WA

Measurement location	Average horizontal hydraulic gradient (ft/ft)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
Toward EW-3, EW-5	0.004	0.004	0.005	0.004
Toward EW-4, EW-10	0.010	0.009	0.010	0.010
Toward EW-6, EW-7	0.010	0.006	0.009	0.008
Toward EW-8, EW-9	Not measurable[b]	Not measurable[b]	0.002	Not measurable[b]

[a]Hydraulic gradients estimated along inferred groundwater flow lines from 2001 intermediate aquifer groundwater elevation contour maps (Figures 3-5 through 3-8).
[b]Insufficient contours to evaluate hydraulic gradient in this area.

As presented in Table 3-9, estimated groundwater flow velocities for the intermediate aquifer ranged from 0.1 ft/d to 5.3 ft/d. The lowest measured velocity was from the area near extraction wells EW-8 and EW-9. This is expected because EW-8 and EW-9 are in an area with a low hydraulic conductivity (10 ft/d) and only intermittent pumping from the extraction wells. The highest calculated groundwater velocities are toward extraction wells EW-6 and EW-7 because of the combination of relatively high horizontal gradients and a hydraulic conductivity of 106 ft/d.

TABLE 3-9
Intermediate Aquifer Groundwater Flow Velocity Estimates
Reichhold, Inc., Tacoma, WA

Measurement location	Linear Velocity (ft/d)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
Toward EW-3, EW-5[a]	1.4	1.4	1.8	1.4
Toward EW-4, EW-10[b]	0.5	0.5	0.5	0.5
Toward EW-6, EW-7[c]	5.3	3.2	4.8	4.2
Toward EW-8, EW-9[b]	NA[d]	NA[d]	0.1	NA[d]

[a]Estimated using hydraulic conductivity of 71 ft/day and hydraulic gradient from Table 3-8.
[b]Estimated using hydraulic conductivity of 10 ft/day and hydraulic gradient from Table 3-8.
[c]Estimated using hydraulic conductivity of 106 ft/day and hydraulic gradient from Table 3-8.
[d]Not analyzed because hydraulic gradient data for this area are not available.

3.2.3 Deep Aquifer

Hydraulic gradient estimates for the deep aquifer are based on inferred flow lines and groundwater elevation contours (Figures 3-9 through 3-12). As presented in Table 3-10, average gradient estimates for the deep aquifer ranged from 0.0004 to 0.0020. Gradients estimated in the off-site area were commonly higher than those on site because of the stronger tidal influence in the off-site area. The deep aquifer groundwater gradients are significantly lower than gradients in either the shallow or the intermediate aquifers.

TABLE 3-10
Deep Aquifer Hydraulic Gradient Estimates[a]
Reichhold, Inc., Tacoma, WA

Measurement location	Average horizontal hydraulic gradient (ft/ft)			
	January 30, 2001	April 26, 2001	July 20, 2001	October 16, 2001
On site	0.0004	0.0012	0.0020	0.0006
Off site	0.0016	0.0014	0.0019	Not measurable[b]

[a]Hydraulic gradients estimated along inferred groundwater flow lines on 2001 deep aquifer groundwater elevation contour maps (Figures 3-9 through 3-12).

[b]Insufficient contours to evaluate hydraulic gradient in this area.

The hydraulic conductivities used to estimate groundwater flow velocities in the deep aquifer (2.0 ft/d to 11.0 ft/d) were based on the *Preclosure Investigation and Hydrogeologic Assessment Report* (CH2M HILL, 1987). The assumed effective porosity of the deep aquifer is 0.2 based on soil classifications from samples obtained during well installation.

As shown in Table 3-11, minimum groundwater flow velocities in the deep aquifer ranged from 0.002 to 0.036 ft/d, and maximum velocities ranged from 0.011 to 0.198 ft/d. Groundwater velocities in the on-site and off-site areas are comparable. Groundwater flow velocities are significantly lower in the deep aquifer than in either the shallow or the intermediate aquifers.

TABLE 3-11
Deep Aquifer Groundwater Flow Velocity Estimates
Reichhold, Inc., Tacoma, WA

Measurement location	Linear Velocity (ft/d)							
	January 30, 2001		April 26, 2001		July 20, 2001		October 16, 2001	
	Min[a]	Max[b]	Min[a]	Max[b]	Min[a]	Max[b]	Min[a]	Max[b]
On site	0.002	0.011	0.015	0.083	0.016	0.088	0.005	0.028
Off site	0.023	0.127	0.031	0.171	0.036	0.198	0.009	0.050

[a]Estimated using hydraulic conductivity of 2.0 ft/d and hydraulic gradients from Table 3-10.

[b]Estimated using hydraulic conductivity of 11.0 ft/d and hydraulic gradients from Table 3-10.

SECTION 4

Pentachlorophenol Removal and Treatment

This section discusses the effectiveness and progress of the groundwater remedial system at Reichhold the facility. PCP was selected as the target constituent for demonstrating the effectiveness and progress of the groundwater remedial system because it was the principal chemical product manufactured at Tacoma's Reichhold facility and is the key constituent associated with manufacturing residues at the site.

Pounds of PCP removed per month are calculated based on average PCP concentrations from weekly groundwater treatment plant influent samples multiplied by the total flow of water through the plant for that month. Based on the sum of the monthly PCP removal results, a total of 388 pounds of PCP was removed from the groundwater during 2001.

Figure 4-1 shows PCP concentrations in treatment plant influent since the groundwater extraction system began operating in 1992. This plot, which is calculated using the total annual amount of PCP removed during each year divided by the volume of water treated, provides information on the trend in mass removal effectiveness of the Tacoma facility extraction system, illustrating progress toward site remediation. As shown in Figure 4-1, the extraction system initially removed groundwater containing fairly high concentrations of PCP (9.0 mg/L). The average concentration of PCP extracted by the treatment system has dropped substantially over time and has reached an asymptotic level of about 1.1 mg/L. The concentration of PCP in the water treatment system rose to 2.0 mg/L in 1999 and 2.2 mg/L in 2000. This increased concentration is likely caused by recent excavation of contaminated soil at the former PCP plant and other areas of the site. The excavations disturbed contaminated soil and temporarily increased dissolution rate of PCP into the groundwater. In 2001 the average PCP concentration measured in the treatment plant influent decreased to 1.1 mg/L.

This type of trend is commonly observed in pump-and-treat systems, particularly when organic constituents that adsorb to the aquifer matrix are involved. This trend indicates that the extraction system has reached its peak level of performance. Therefore, while the extraction system continues to be effective at hydraulically containing PCP in groundwater at the site, continued operation of the extraction system is unlikely to achieve the current groundwater protection standard of 0.001 mg/L.

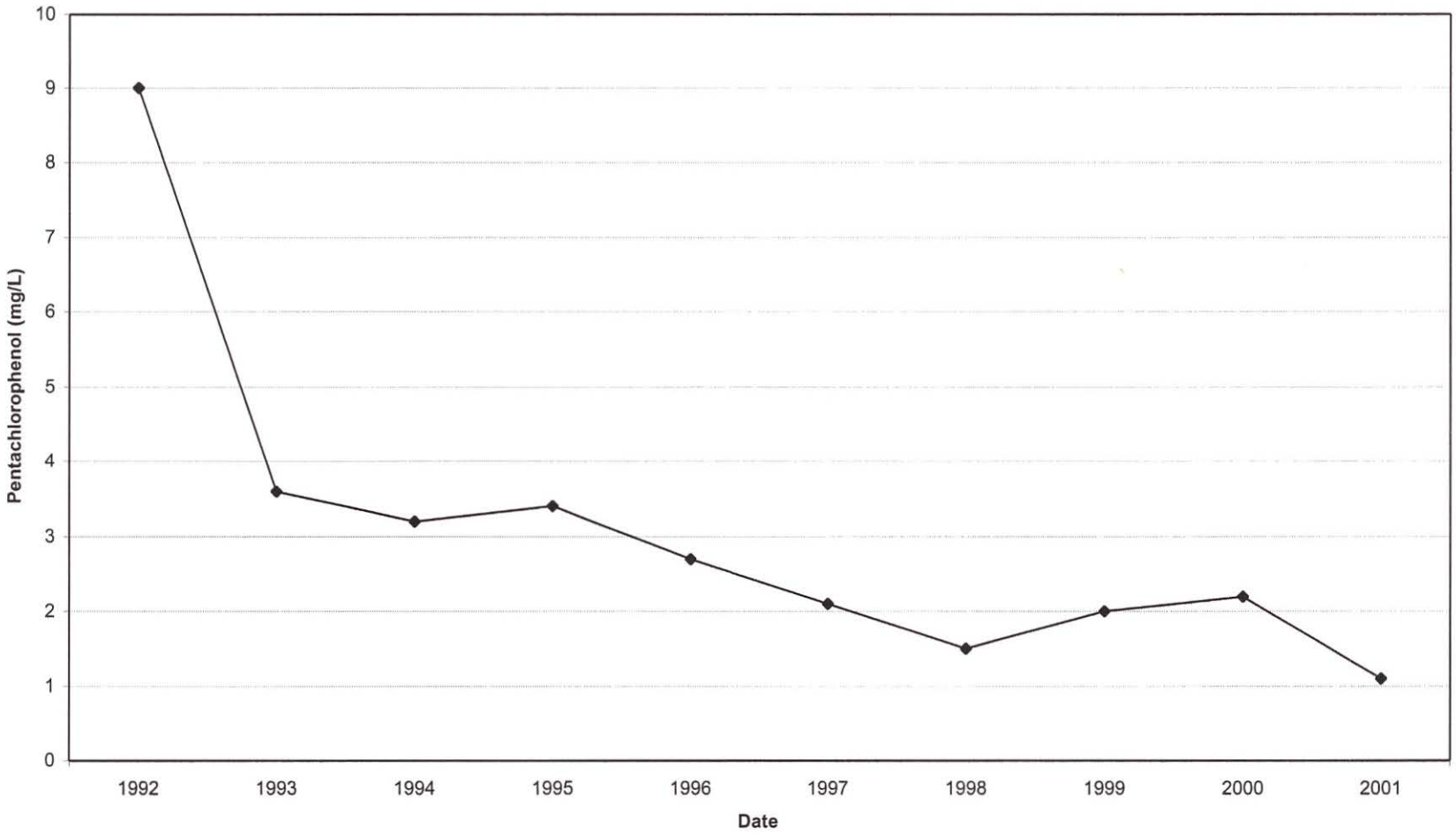


FIGURE 4-1
Average Pentachlorophenol Concentrations
in Treatment Plant Influent (1992-2001)
Reichhold, Inc., Tacoma, WA

SECTION 5

References

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APPENDIX A

2001 Groundwater Quality Results Summary Tables

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
Reichhold Part B Permit No. WAD 009 252 891)
33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-1(S)	MW-2(S)2	MW-4(S)	MW-9(S)	MW-12(S)	MW-14(S)	MW-21(S)2	MW-27(S)	MW-42(S)2	MW-51(S)	MW-56(S)
INORGANICS (ug/L)													
antimony[d]	14	6	14 U	14 U	14 U	15 B	15 B	14 U	22 B	14 U	14 U	14 U	14 U
arsenic	0.7 - 350	50	1.1 B	0.70 U	9.5 B	6.6 B	1.4 B	1.6 B	2.2 B	7.2 B	6.1 B	1.5 B	0.70 U
barium	2	2000	2.0 U	2.0 U	5.5 B	4.0 B	5.1 B	9.7 B	7.8 B	3.5 B	66 B	27 B	2.0 U
beryllium	1	4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	4.0 B	1.0 U	1.0 U	1.0 U	1.0 U
cadmium	1	10	1.0 U	1.0 U	1.5 B	1.0 U	1.0 U	1.0 U	9.2	1.0 U	1.0 U	1.0 U	1.0 U
chromium	1	50	1.7 B	1.0 U	1.0 U	1.0 U	1.0 U	1.8 B	1.0 U	1.0 U	1.0 U	1.0 U	3.5 B
cobalt	2	365	4.6 B	2.5 B	2.0 U	16 B	12 B	2.0 U	192	2.0 U	10 B	14 B	11 B
copper	1	2.9	2.9 B	1.2 B	1.8 B	2.4 B	4.1 B	11 B	174	1.0 U	1.0 U	5.2 B	9.2 B
cyanide	10 - 50	200	10 U	[e]	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cyanide, amenable	10 - 50	200	[f]	[e]	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]
lead	0.3 - 3	50	0.30 U	0.30 U	0.30 U	0.46 B	0.30 U	2.7 B	1.4 B	0.30 U	0.30 U	0.45 B	0.30 U
manganese	2	536-763[c]	5.2 B	630	262	739	323	801	1,960	46	1,500	218	23
mercury	0.10	2	0.10 UN	0.10 U	0.14 B	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UN
molybdenum	4	182	5.8 B	4.0 U	1,220	4.0 U	1,730	18	7.9 B	4.3 B	130	6.1 B	2,850
nickel	6	100	8.8 B	6.0 U	6.0 U	55	22 B	6.0 U	390	6.0 U	8.3 B	31 B	6.0 U
silver	3	50	4.7 B	3.0 U	3.0 U	4.0 B	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
vanadium	1	700	1.9 B	1.0 U	14 B	3.6 B	1.8 B	6.3 B	8.1 B	4.4 B	1.0 U	1.0 U	1.0 U
zinc	2	86	2.0 U	2.0 U	2.0 U	89	22	20 B	492	2.0 U	2.9 B	50	12 B
PCBs(ug/L)													
aroclor-1248[d]	1 - 20	0.50	1.1 U	[e]	1.0 U	1.0 U	1.0 U	10 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
SEMIVOLATILE ANALYSIS (ug/L)													
2,3,4,6-tetrachlorophenol	10 - 2100	10000	10 U	10 U	10 U	10 U	10 U	13,000 D	10 U	10 U	10 U	10 U	10 U
2,4,6-trichlorophenol[d]	10 - 2100	1	10 U	10 U	10 U	10 U	10 U	14,000 D	10 U	10 U	10 U	10 U	10 U
2,4-dichlorophenol	10 - 100	100	10 U	10 U	10 U	10 U	10 U	690 D	10 U	10 U	10 U	10 U	10 U
2-benzyl-4-chlorophenol	10	10	10 U	10 U	10 U	10 U	10 U	8.0 J	10 U	10 U	10 U	10 U	10 U
2-chlorophenol	10	200	10 U	10 U	10 U	10 U	10 U	58	10 U	10 U	10 U	10 U	10 U
2-methylnaphthalene	10	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	6.8 J	10 U	10 U	10 U	10 U	10 U
4-chloro-3-methylphenol	10	30	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	23	10 U	10 U	10 U	10 U	10 U
acenaphthene	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
benzoic acid	50 - 52	146000	52 U	50 U	50 U	52 U	50 U	52 U	52 U	52 U	50 U	50 U	50 U

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
Reichhold Part B Permit No. WAD 009 252 891)
33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-1(S)	MW-2(S)2	MW-4(S)	MW-9(S)	MW-12(S)	MW-14(S)	MW-21(S)2	MW-27(S)	MW-42(S)2	MW-51(S)	MW-56(S)
bis(2-ethylhexyl)phthalate[d]	10	6	10 U	10 U	10 U	6.4 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U
di-n-octyl phthalate	10	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
naphthalene	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
p-tert-butylphenol	10 - 100	1000	10 U	4.4 J	28	10 U	10 U	400 D	10 U	10 U	10 U	10 U	10 U
pentachlorophenol[d]	25 - 5200	1	26 U	25 U	25 U	26 U	25 U	13,000 D	26 U	26 U	1.6 J	25 U	25 U
phenol	10 - 100	1000	10 U	10 U	10 U	10 U	10 U	460 D	10 U	10 U	10 U	10 U	10 U
VOLATILE ANALYSIS (ug/L)													
1,1-dichloroethane	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	44	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-methyl-2-pentanone	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
acetone	10	3500	10 U	10 U	10 U	44	10 U	10	10 U	5.0 J	10 U	10 U	10 U
benzene	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
ethylbenzene	5 - 25	700	5.0 U	5.0 U	6.0	5.0 U	5.0 U	190 D	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
formaldehyde	20	50	21	20 U	20 U	20 U	20 U	60	71	23	20 U	25	20 U
methylene chloride	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tetrachloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.0 J
toluene	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	8.0	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-dichloroethene	5	100	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trichloroethene	5 - 25	5	5.0 U	5.0 U	2.0 J	5.0 U	5.0 U	92	5.0 U	5.0 U	12	5.0 U	5.0 U
trichlorofluoromethane	10	22500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
vinyl chloride	2	2	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	35	2.0 U	2.0 U	1.0 J	2.0 U	2.0 U

[a] EPA contract required detection limits (CLP, 1988)

[b] Groundwater Protection Standard from Table 7 of Permit WAD009252891.

[c] GWPS for shallow aquifer-536 ug/L; GWPS for intermediate aquifer-763 ug/L

[d] Estimated value below detection limit reported because GWPS is below detection limit.

[e] Insufficent well recovery to fill all sample containers

[f] Amenable cyanide analysis is only performed if total cyanide is detected

Subsample: FD = Field Duplicate

Qualifiers: U=Parameter analyzed for but not detected above the concentration listed

J=Indicates an estimated value.

B=(Inorganic compounds) The reported value obtained was less than the Contract Required Detection Limit (CRDL), but equal or greater to the Instrument Detection Limit (IDL)

B=(Organic compounds) Compound was also detected in the laboratory method blank.

D=(Organic compounds) Indicates compounds which have been identified during a diluted reanalysis

W=Graphite furnace analytical spike not within control limits (85% - 115%).

N=Spiked sample recovery not within control limits.

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
Reichhold Part B Permit No. WAD 009 252 891)
33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-2(I)	MW-4(I)2	MW-7(I)	MW-12(I)	MW-16(I)	MW-17(I)	MW-22(I)	MW-28(I)	MW-30(I)	MW-36(I)
INORGANICS (ug/L)												
antimony[d]	14	6	20 B	14 U	14 U	51 B	55 B	350	57 B	44 B	14 U	43 B
arsenic	0.7 - 350	50	1.6 B	3.1 B	6.8 BW	0.70 U	5.2 B	3.5 UW	0.70 UW	3.5 U	6.1 B	4.9 B
barium	2	2000	33 B	18 B	42 B	135 B	55 B	240	26 B	69 B	67 B	30 B
beryllium	1	4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
cadmium	1	10	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.1 B	1.0 U	1.0 U
chromium	1	50	12	46	34	1.0 U	4.0 B	1.0 U	6.1 B	1.0 U	5.1 B	11
cobalt	2	365	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.8 B	3.0 B	2.0 U	2.0 U
copper	1	2.9	2.5 B	2.7 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	3.8 B	1.0 U	1.0 U
cyanide	10 - 50	200	10 U	10 U	14	10 U	286	77	10 U	10 U	10 U	10 U
cyanide, amenable	10 - 50	200	[f]	[f]	10 U	[f]	50 U	50 U	[f]	[f]	[f]	[f]
lead	0.3 - 3	50	1.2 B	1.2 B	3.0 U	0.30 UW	11 B	11 B	11 B	0.75 BW	0.32 B	3.0 B
manganese	2	536-763[c]	539	385	558	4,310	1,070	1,690	287	2,140	921	80
mercury	0.10	2	0.10 UN	0.10 U	0.10 UN	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UN
molybdenum	4	182	52	4.1 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.3 B	106	4.0 U
nickel	6	100	6.2 B	8.4 B	6.0 U	9.6 B	6.0 U	6.0 U	6.0 U	21 B	6.0 U	6.0 U
silver	3	50	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
vanadium	1	700	34 B	155	158	8.7 B	22 B	41 B	40 B	13 B	16 B	65
zinc	2	86	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	3.8 B	743	2.0 U	2.0 U
PCBs(ug/L)												
aroclor-1248[d]	1 - 20	0.50	1.0 U	1.0 U	1.0 U	1.1 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
SEMIVOLATILE ANALYSIS (ug/L)												
2,3,4,6-tetrachlorophenol	10 - 2100	10000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	160 D	10 U
2,4,6-trichlorophenol[d]	10 - 2100	1	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	4.4 J	10 U
2,4-dichlorophenol	10 - 100	100	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	23	10 U
2-benzyl-4-chlorophenol	10	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-chlorophenol	10	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	6.9 J	10 U
2-methylnaphthalene	10	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	1.5 J	10 U
4-chloro-3-methylphenol	10	30	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	1.0 J	10 U
acenaphthene	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
benzoic acid	50 - 52	146000	52 U	52 U	51 U	50 U	50 U	50 U	50 U	50 U	52 U	52 U

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
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33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-2(I)	MW-4(I)2	MW-7(I)	MW-12(I)	MW-16(I)	MW-17(I)	MW-22(I)	MW-28(I)	MW-30(I)	MW-36(I)
bis(2-ethylhexyl)phthalate[d]	10	6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
di-n-octyl phthalate	10	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
naphthalene	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
p-tert-butylphenol	10 - 100	1000	10 U	4.6 J	10 U	10 U	10 U	10 U	10 U	10 U	20	10 U
pentachlorophenol[d]	25 - 5200	1	26 U	26 U	26 U	25 U	25 U	25 U	25 U	25 U	1,300 D	26 U
phenol	10 - 100	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	1.3 J	10 U
VOLATILE ANALYSIS (ug/L)												
1,1-dichloroethane	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-methyl-2-pentanone	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
acetone	10	3500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
benzene	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	8.0	5.0 U
ethylbenzene	5 - 25	700	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.0 J	5.0 U
formaldehyde	20	50	21	25	84	28	27	20 U	20 U	20 U	24	170
methylene chloride	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tetrachloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
toluene	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-dichloroethene	5	100	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trichloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	23	5.0 U
trichlorofluoromethane	10	22500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
vinyl chloride	2	2	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U

[a] EPA contract required detection limits (CLP, 1988)

[b] Groundwater Protection Standard from Table 7 of Permit WAD009252891.

[c] GWPS for shallow aquifer-536 ug/L; GWPS for intermediate aquifer-763 ug/L

[d] Estimated value below detection limit reported because GWPS is below detection limit.

[e] Insufficent well recovery to fill all sample containers

[f] Amenable cyanide analysis is only performed if total cyanide is detected

Subsample: FD = Field Duplicate

Qualifiers: U=Parameter analyzed for but not detected above the concentration listed.

J=Indicates an estimated value.

B=(Inorganic compounds) The reported value obtained was less than the Contract Required Detection Limit (CRDL), but equal or greater to the Instrument Detection Limit (IDL).

B=(Organic compounds) Compound was also detected in the laboratory method blank.

D=(Organic compounds) Indicates compounds which have been identified during a diluted reanalysis.

W=Graphite furnace analytical spike not within control limits (85% - 115%).

N=Spiked sample recovery not within control limits.

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
Reichhold Part B Permit No. WAD 009 252 891)
33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-37(I)	MW-39(I)	MW-41(I)	MW-44(I)	MW-44(I)-FD	MW-45(I)	MW-46(I)	MW-46(I)-FD	MW-48(I)
INORGANICS (ug/L)											
antimony[d]	14	6	27 B	21 B	36 B	86	106	58 B	27 B	15 B	14 U
arsenic	0.7 - 350	50	5.0 B	6.2 B	0.81 BW	3.5 UW	3.5 UW	12,400	3.5 U	3.5 U	1.1 B
barium	2	2000	23 B	101 B	16 B	64 B	64 B	26 B	29 B	24 B	9.0 B
beryllium	1	4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	3.8 B	1.0 U	1.0 U
cadmium	1	10	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	31	4.0 B	1.2 B	1.0 U
chromium	1	50	92	19	1.0 U	1.0 U	1.0 U	1.0 U	5.3 B	5.2 B	7.8 B
cobalt	2	365	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	4.1 B	3.3 B	3.5 B
copper	1	2.9	8.4 B	2.7 B	1.0 U	1.0 U	1.0 U	1.0 U	4.8 B	3.8 B	2.3 B
cyanide	10 - 50	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cyanide, amenable	10 - 50	200	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]
lead	0.3 - 3	50	4.3	0.88 B	1.4 BW	8.8 BW	7.6 BW	1.5 U	0.88 B	0.80 B	0.96 B
manganese	2	536-763[c]	384	731	1,340	443	438	549	815	786	173
mercury	0.10	2	0.10 U	0.10 UN	0.10 U	0.11 B	0.10 U	0.10 U	0.10 U	0.10 U	0.10 UN
molybdenum	4	182	4.0 U	4.0 U	4.0 U	4.6 B	4.0 U	277	4.9 B	8.9 B	331
nickel	6	100	6.0 U	6.0 U	6.0 U	6.0 U	8.9 B	6.0 U	6.0 U	9.8 B	6.0 U
silver	3	50	3.5 B	3.0 U	3.0 U	3.0 U	3.7 B	3.0 U	3.0 U	3.5 B	3.0 U
vanadium	1	700	322	79	8.5 B	8.7 B	11 B	6.1 B	20 B	18 B	16 B
zinc	2	86	5.6 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.2 B	2.0 U	2.0 U
PCBs(ug/L)											
aroclor-1248[d]	1 - 20	0.50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
SEMIVOLATILE ANALYSIS (ug/L)											
2,3,4,6-tetrachlorophenol	10 - 2100	10000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4,6-trichlorophenol[d]	10 - 2100	1	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-dichlorophenol	10 - 100	100	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-benzyl-4-chlorophenol	10	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-chlorophenol	10	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-methylnaphthalene	10	10	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-chloro-3-methylphenol	10	30	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-methylphenol	10	2000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
acenaphthene	10	2000	4.0 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
benzoic acid	50 - 52	146000	50 U	51 U	50 U	52 U	52 U	52 U	50 U	50 U	52 U

APPENDIX A
Analytical Results
(Required Parameters Listed in Table 7 of
Reichhold Part B Permit No. WAD 009 252 891)
33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-37(I)	MW-39(I)	MW-41(I)	MW-44(I)	MW-44(I)-FD	MW-45(I)	MW-46(I)	MW-46(I) FD	MW-48(I)
bis(2-ethylhexyl)phthalate[d]	10	6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
di-n-octyl phthalate	10	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
naphthalene	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
p-tert-butylphenol	10 - 100	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	1.7 J
pentachlorophenol[d]	25 - 5200	1	25 U	26 U	25 U	26 U	26 U	26 U	25 U	25 U	26 U
phenol	10 - 100	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
VOLATILE ANALYSIS (ug/L)											
1,1-dichloroethane	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-methyl-2-pentanone	10	1000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
acetone	10	3500	10 U	24	10 U	10 U	10 U	10 U	10 U	10 U	10 U
benzene	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	4.0 J
ethylbenzene	5 - 25	700	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
formaldehyde	20	50	27	72	20 U	20 U	20 U	20 U	66	59	38
methylene chloride	5	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
tetrachloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
toluene	5	1000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,2-dichloroethene	5	100	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	4.0 J
trichloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trichlorofluoromethane	10	22500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
vinyl chloride	2	2	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U

[a] EPA contract required detection limits (CLP, 1988)

[b] Groundwater Protection Standard from Table 7 of Permit WAD009252891.

[c] GWPS for shallow aquifer-536 ug/L; GWPS for intermediate aquifer-763 ug/L

[d] Estimated value below detection limit reported because GWPS is below detection limit.

[e] Insufficent well recovery to fill all sample containers

[f] Amenable cyanide analysis is only performed if total cyanide is detectec

Subsample: FD = Field Duplicate

Qualifiers: U=Parameter analyzed for but not detected above the concentration listed.

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B=(Organic compounds) Compound was also detected in the laboratory method blank

D=(Organic compounds) Indicates compounds which have been identified during a diluted reanalysis.

W=Graphite furnace analytical spike not within control limits (85% - 115%).

N=Spiked sample recovery not within control limits.

APPENDIX A
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33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-50(I)	MW-53(I)	MW-53(I)-FD
INORGANICS (ug/L)					
antimony[d]	14	6	20 B	45 B	48 B
arsenic	0.7 - 350	50	3.9 B	0.70 U	0.83 B
barium	2	2000	24 B	134 B	132 B
beryllium	1	4	1.0 U	1.0 U	1.0 U
cadmium	1	10	1.2 B	1.0 U	1.0 U
chromium	1	50	19	1.0 U	1.0 U
cobalt	2	365	4.7 B	2.0 U	2.0 U
copper	1	2.9	3.6 B	1.0 U	1.0 U
cyanide	10 - 50	200	10 U	10 U	10 U
cyanide, amenable	10 - 50	200	[f]	[f]	[f]
lead	0.3 - 3	50	1.9 BW	0.41 B	0.30 U
manganese	2	536-763[c]	522	5,430	5,450
mercury	0.10	2	0.10 UN	0.10 UN	0.10 UN
molybdenum	4	182	4.0 U	245	232
nickel	6	100	9.4 B	6.0 U	6.0 U
silver	3	50	3.5 B	3.0 U	3.0 U
vanadium	1	700	79	1.0 U	1.0 U
zinc	2	86	2.0 U	2.0 U	2.0 U
PCBs(ug/L)					
aroclor-1248[d]	1 - 20	0.50	1.0 U	1.0 U	1.0 U
SEMIVOLATILE ANALYSIS (ug/L)					
2,3,4,6-tetrachlorophenol	10 - 2100	10000	10 U	10 U	10 U
2,4,6-trichlorophenol[d]	10 - 2100	1	10 U	10 U	10 U
2,4-dichlorophenol	10 - 100	100	10 U	10 U	10 U
2-benzyl-4-chlorophenol	10	10	10 U	10 U	10 U
2-chlorophenol	10	200	10 U	10 U	10 U
2-methylnaphthalene	10	10	10 U	10 U	10 U
2-methylphenol	10	2000	10 U	10 U	10 U
4-chloro-3-methylphenol	10	30	10 U	10 U	10 U
4-methylphenol	10	2000	10 U	10 U	10 U
acenaphthene	10	2000	10 U	10 U	10 U
benzoic acid	50 - 52	146000	52 U	50 U	51 U

APPENDIX A
Analytical Results
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33rd Quarter of CAMP, July 2001
Reichhold, Inc., Tacoma, WA

Lab Parameter	Detection Limit[a]	GWPS[b]	MW-50(I)	MW-53(I)	MW-53(I)-FD
bis(2-ethylhexyl)phthalate[d]	10	6	10 U	10 U	10 U
di-n-octyl phthalate	10	700	10 U	10 U	10 U
naphthalene	10	1000	10 U	10 U	10 U
p-tert-butylphenol	10 - 100	1000	10 U	10 U	10 U
pentachlorophenol[d]	25 - 5200	1	26 U	25 U	26 U
phenol	10 - 100	1000	10 U	10 U	10 U
VOLATILE ANALYSIS (ug/L)					
1,1-dichloroethane	5	1000	5.0 U	5.0 U	5.0 U
4-methyl-2-pentanone	10	1000	10 U	10 U	10 U
acetone	10	3500	10 U	10 U	10 U
benzene	5	5	5.0 U	5.0 U	5.0 U
ethylbenzene	5 - 25	700	5.0 U	5.0 U	5.0 U
formaldehyde	20	50	130	92	90
methylene chloride	5	5	5.0 U	5.0 U	5.0 U
tetrachloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U
toluene	5	1000	5.0 U	5.0 U	5.0 U
trans-1,2-dichloroethene	5	100	5.0 U	8.0	9.0
trichloroethene	5 - 25	5	5.0 U	5.0 U	5.0 U
trichlorofluoromethane	10	22500	10 U	10 U	10 U
vinyl chloride	2	2	2.0 U	9.0	12

[a] EPA contract required detection limits (CLP, 1988)

[b] Groundwater Protection Standard from Table 7 of Permit WAD009252891.

[c] GWPS for shallow aquifer-536 ug/L; GWPS for intermediate aquifer-763 ug/L

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Subsample: FD = Field Duplicate

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B=(Organic compounds) Compound was also detected in the laboratory method blank.
D=(Organic compounds) Indicates compounds which have been identified during a diluted reanalysis.
W=Graphite furnace analytical spike not within control limits (85% - 115%).
N=Spiked sample recovery not within control limits.

APPENDIX A

Modified Appendix IX Results

Water Treatment Plant Influent

33rd Quarter of CAMP, July 2001

Reichhold, Inc., Tacoma, WA

	Value	Qualifier	Units
CONVENTIONAL ANALYSES			
total organic carbon	23		mg/L
pH	6.8		units
INORGANIC ANALYSES			
aluminum	177	B	ug/L
antimony	41	B	ug/L
arsenic	1,050		ug/L
barium	79	B	ug/L
beryllium	1.0	U	ug/L
cadmium	1.0	B	ug/L
calcium	341,000		ug/L
chromium	5.6	B	ug/L
cobalt	2.0	U	ug/L
copper	1.0	U	ug/L
cyanide, distilled	10	U	ug/L
iron	30,600		ug/L
lead	1.0	BW	ug/L
magnesium	187,000		ug/L
manganese	1,340		ug/L
mercury	0.10	UN	ug/L
molybdenum	238		ug/L
nickel	7.7	B	ug/L
potassium	67,700		ug/L
selenium	7.0	U	ug/L
silver	3.0	U	ug/L
sodium	1,280,000		ug/L
thallium	0.80	U	ug/L
vanadium	27	B	ug/L
zinc	2.0	U	ug/L
PCB's ANALYSES			
aroclor-1248	20	U	ug/L
SEMIVOLATILE ANALYSES			
1,2,4-trichlorobenzene	10	U	ug/L
1,2-dichlorobenzene	10	U	ug/L
1,3-dichlorobenzene	10	U	ug/L
1,4-dichlorobenzene	10	U	ug/L
2,2'-oxybis(1-chloropropane)	10	U	ug/L
2,3,4,6-tetrachlorophenol	88	D	ug/L
2,3-dimethylaniline	10	U	ug/L
2,4,5-trichlorophenol	7.9	J	ug/L
2,4,6-trichlorophenol	3.5	J	ug/L
2,4-dichlorophenol	6.9	J	ug/L
2,4-dimethylaniline	10	U	ug/L
2,4-dinitrophenol	26	U	ug/L
2,4-dinitrotoluene	10	U	ug/L
2,4-dimethyphenol	10	U	ug/L
2,5-dimethylaniline	10	U	ug/L
2,6-dimethylaniline	10	U	ug/L
2,6-dinitrotoluene	10	U	ug/L
2-benzyl-4-chlorophenol	10	U	ug/L
2-chloronaphthalene	8.4	J	ug/L
2-chlorophenol	63		ug/L

APPENDIX A

Modified Appendix IX Results

Water Treatment Plant Influent

33rd Quarter of CAMP, July 2001

Reichhold, Inc., Tacoma, WA

	Value	Qualifier	Units
2-methylnaphthalene	10	U	ug/L
2-methylphenol	10	U	ug/L
2-nitroaniline	26	U	ug/L
2-nitrophenol	10	U	ug/L
3,3'-dichlorobenzidine	10	U	ug/L
3,4-dimethylaniline	10	U	ug/L
3,5-dimethylaniline	10	U	ug/L
3-nitroaniline	26	U	ug/L
4,6-dinitro-2-methylphenol	26	U	ug/L
4-bromophenyl-phenylether	10	U	ug/L
4-chloro-3-methylphenol	10	U	ug/L
4-chloroaniline	10	U	ug/L
4-chlorophenyl-phenylether	10	U	ug/L
4-methylphenol	10	U	ug/L
4-nitroaniline	26	U	ug/L
4-nitrophenol	26	U	ug/L
acenaphthene	10	U	ug/L
acenaphthylene	10	U	ug/L
anthracene	10	U	ug/L
benzo(a)anthracene	10	U	ug/L
benzo(a)pyrene	10	U	ug/L
benzo(b)fluoroanthene	10	U	ug/L
benzo(g,h,i)perylene	10	U	ug/L
benzo(k)fluoranthene	10	U	ug/L
benzoic acid	2.7	J	ug/L
benzyl alcohol	10	U	ug/L
bis(2-chloroethoxy)methane	10	U	ug/L
bis(2-chloroethyl)ether	10	U	ug/L
bis(2-ethylhexyl)phthalate	10	U	ug/L
butylbenzylphthalate	10	U	ug/L
carbazole	10	U	ug/L
chrysene	10	U	ug/L
di-n-butylphthalate	10	U	ug/L
di-n-octylphthalate	10	U	ug/L
dibenzo(a,h)anthracene	10	U	ug/L
dibenzofuran	10	U	ug/L
diethylphthalate	10	U	ug/L
dimethylphthalate	10	U	ug/L
fluoranthene	10	U	ug/L
fluorene	10	U	ug/L
hexachlorobenzene	10	U	ug/L
hexachlorobutadiene	10	U	ug/L
hexachlorocyclopentadiene	10	U	ug/L
hexachloroethane	10	U	ug/L
indeno(1,2,3-cd)pyrene	10	U	ug/L
isophorone	10	U	ug/L
n,n-dimethylaniline	10	U	ug/L
n-nitroso-di-n-propylamine	10	U	ug/L
n-nitrosodiphenylamine	10	U	ug/L
naphthalene	10	U	ug/L
nitrobenzene	10	U	ug/L
p-benzoquinone	10	U	ug/L

APPENDIX A

Modified Appendix IX Results

Water Treatment Plant Influent

33rd Quarter of CAMP, July 2001

Reichhold, Inc., Tacoma, WA

	Value	Qualifier	Units
pentachlorophenol	1,300	D	ug/L
phenanthrene	10	U	ug/L
phenol	76		ug/L
pyrene	10	U	ug/L
p-tert-butylphenol	39		ug/L
VOLATILE ANALYSES			
1,1,1-trichloroethane	5.0	U	ug/L
1,1,2,2-tetrachloroethane	5.0	U	ug/L
1,1,2-trichloroethane	5.0	U	ug/L
1,1-dichloroethane	5.0	U	ug/L
1,1-dichloroethene	5.0	U	ug/L
1,2-dichloroethane	5.0	U	ug/L
1,2-dichloroethene (total)	97		ug/L
1,2-dichloropropane	5.0	U	ug/L
2-butanone	10	U	ug/L
2-hexanone	10	U	ug/L
4-methyl-2-pentanone	10	U	ug/L
acetone	10	U	ug/L
benzene	7.0		ug/L
bromodichloromethane	5.0	U	ug/L
bromoform	5.0	U	ug/L
bromomethane	10	U	ug/L
carbon disulfide	5.0	U	ug/L
carbon tetrachloride	5.0	U	ug/L
chlorobenzene	5.0	U	ug/L
chloroethane	10	U	ug/L
chloroform	5.0	U	ug/L
chloromethane	10	U	ug/L
cis-1,3-dichloropropene	5.0	U	ug/L
dibromochloromethane	5.0	U	ug/L
ethylbenzene	3.0	J	ug/L
formaldehyde	33		ug/L
methylene chloride	5.0	U	ug/L
styrene	5.0	U	ug/L
tetrachloroethene	180	D	ug/L
toluene	1.0	J	ug/L
trans-1,3-dichloropropene	5.0	U	ug/L
trichloroethene	100	D	ug/L
vinyl acetate	10	U	ug/L
vinyl chloride	26		ug/L
xylene(total)	5.0	U	ug/L

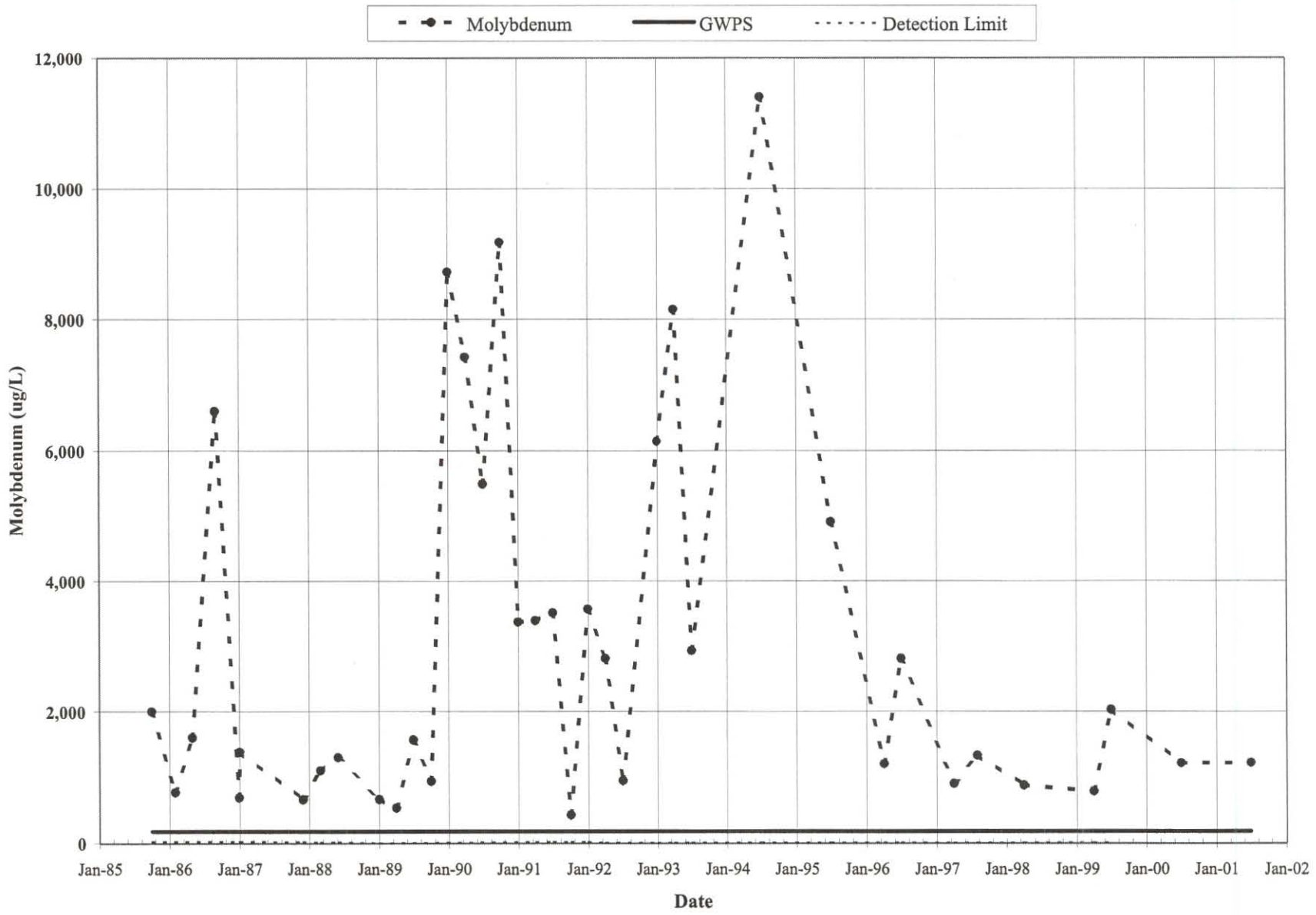
Data Qualifiers:

U = Parameter analyzed for but not detected above the concentration listed.
B = (Inorganic Compounds) the reported value obtained was less than the Contract Required Detection Limit (CRDL), but greater or equal to the Instrument Detection Limit (IDL).
B = (Organic Compounds) Compound was also detected in the laboratory method blank
N= (Inorganic Compounds) spiked sample recovery not within control limits.
W= (Inorganic Compounds) graphite furnace analytical spike not within control limits (85% - 115%).
D = (Organic Compounds) Indicates compounds which have been identified during a diluted reanalysis.
J = Indicates an estimated value.

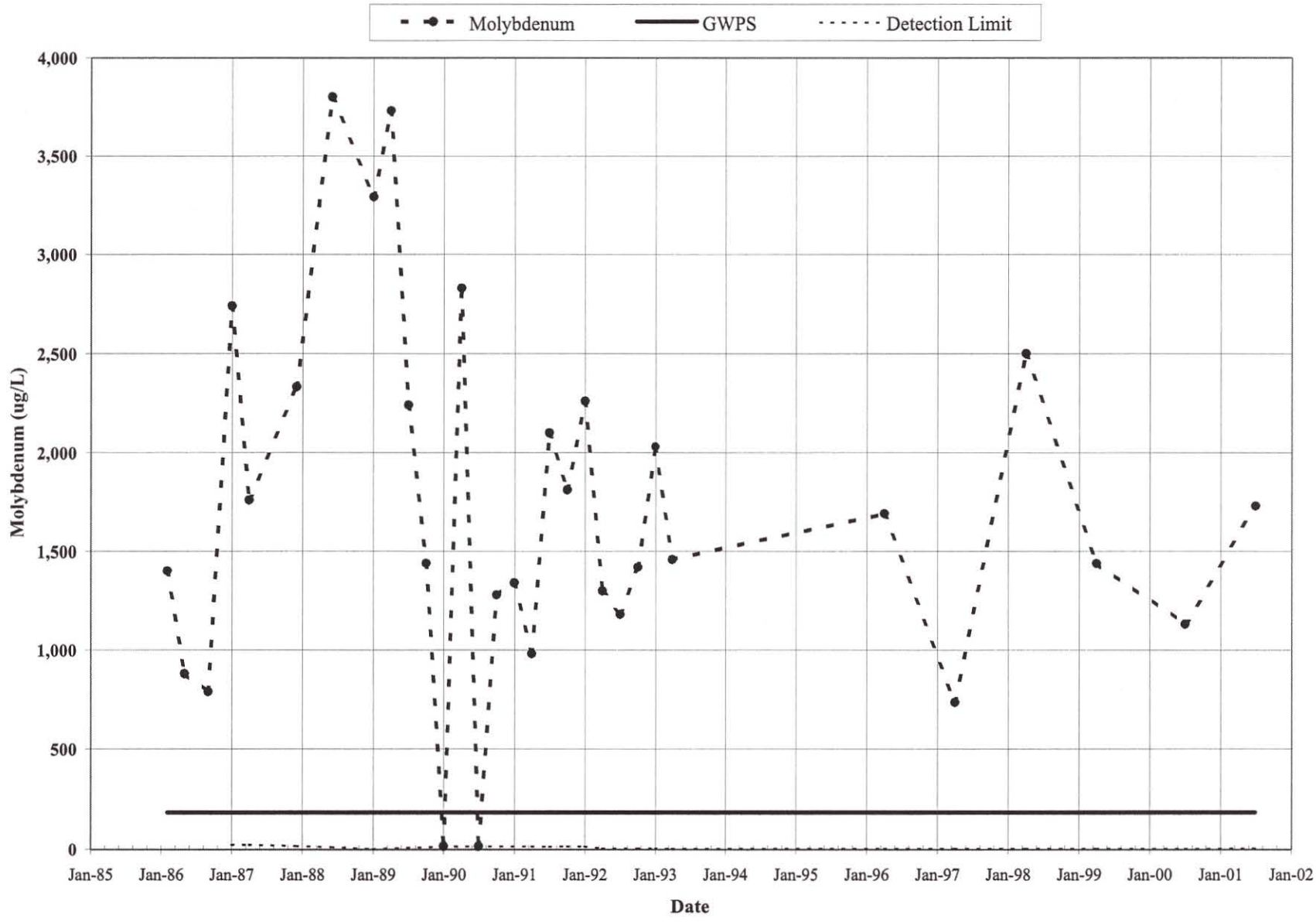
APPENDIX B

Shallow Aquifer Time-Concentration Plots

MW-4(S) Molybdenum

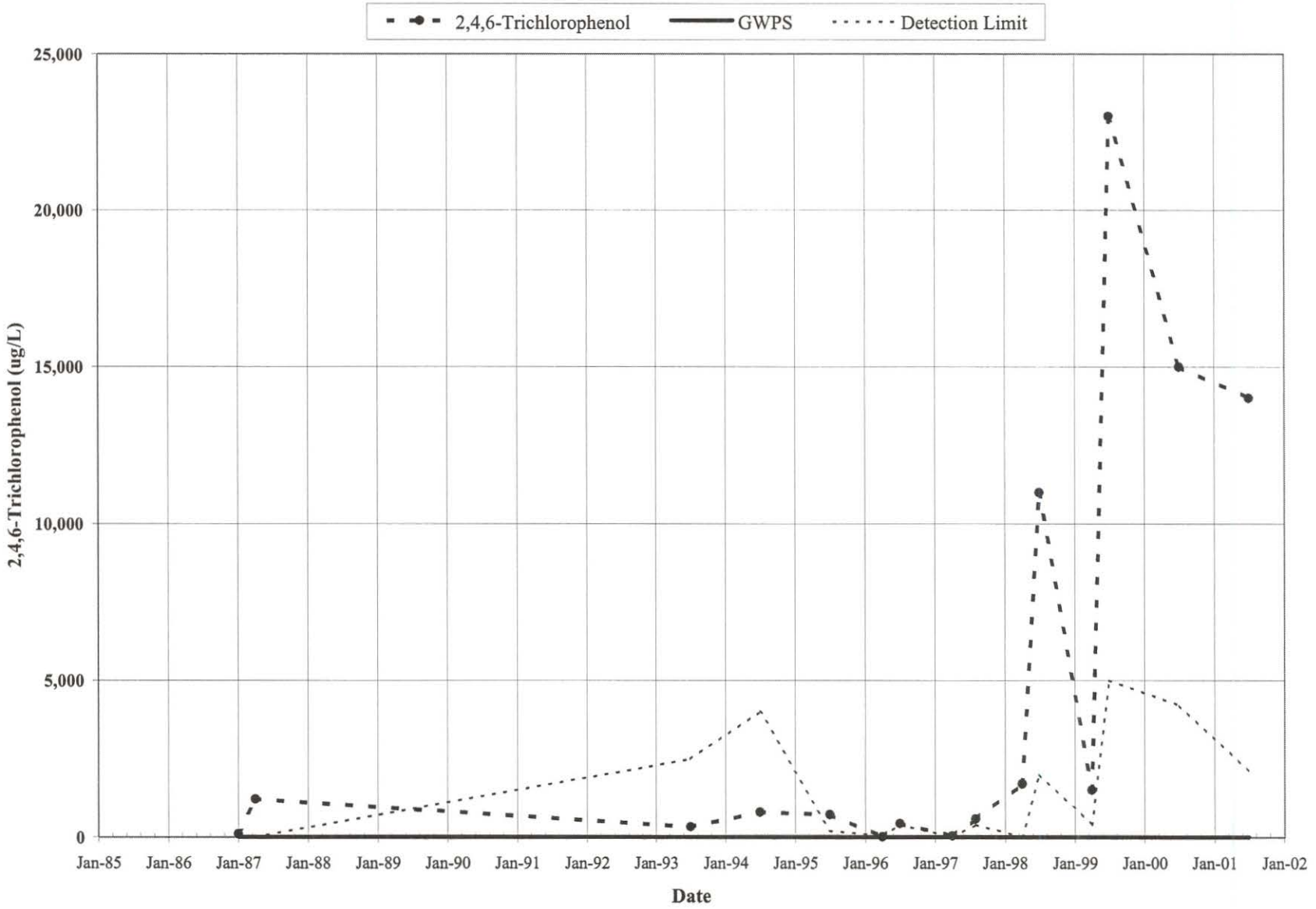


MW-12(S) Molybdenum

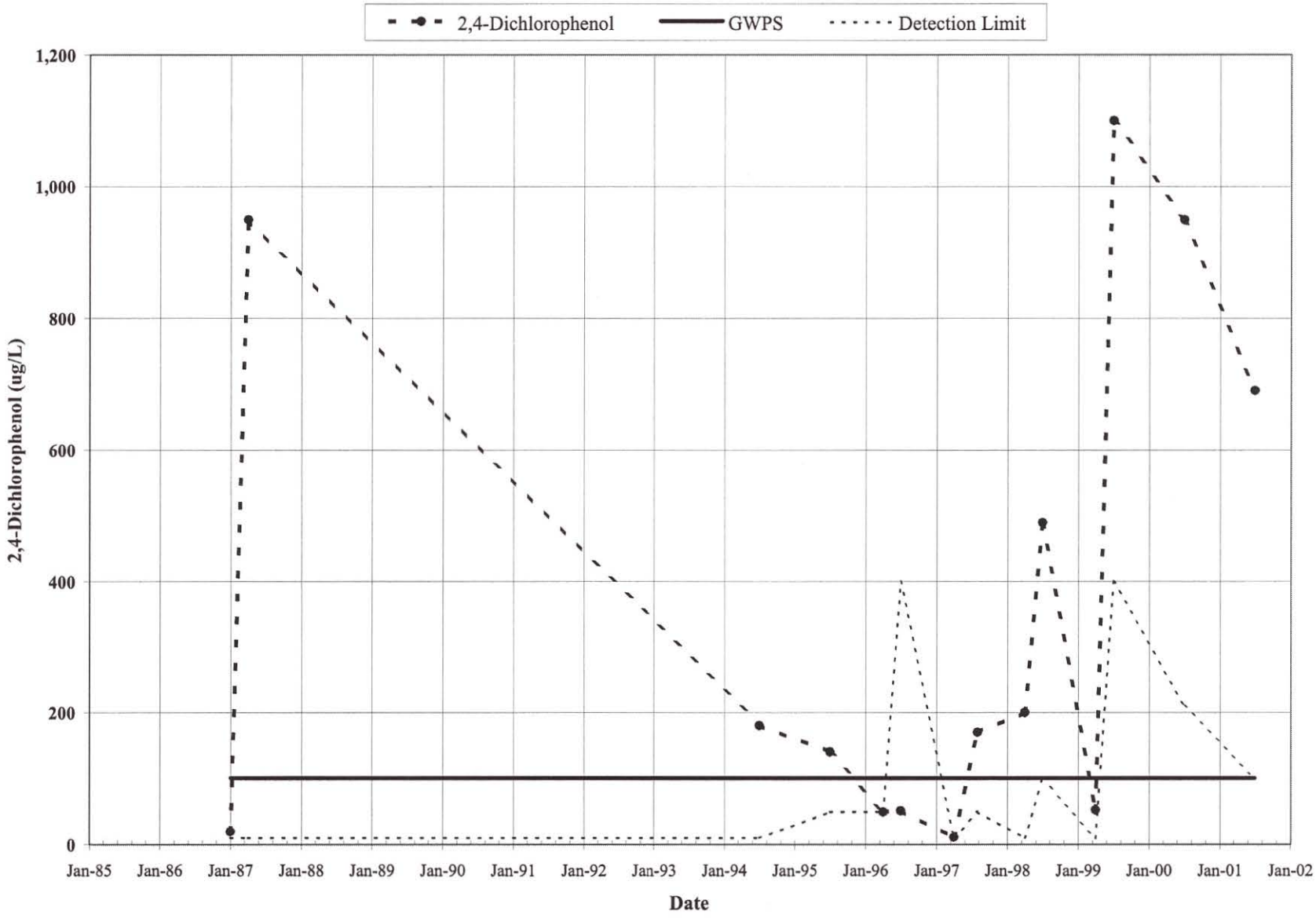


MW-14(S)

2,4,6-Trichlorophenol

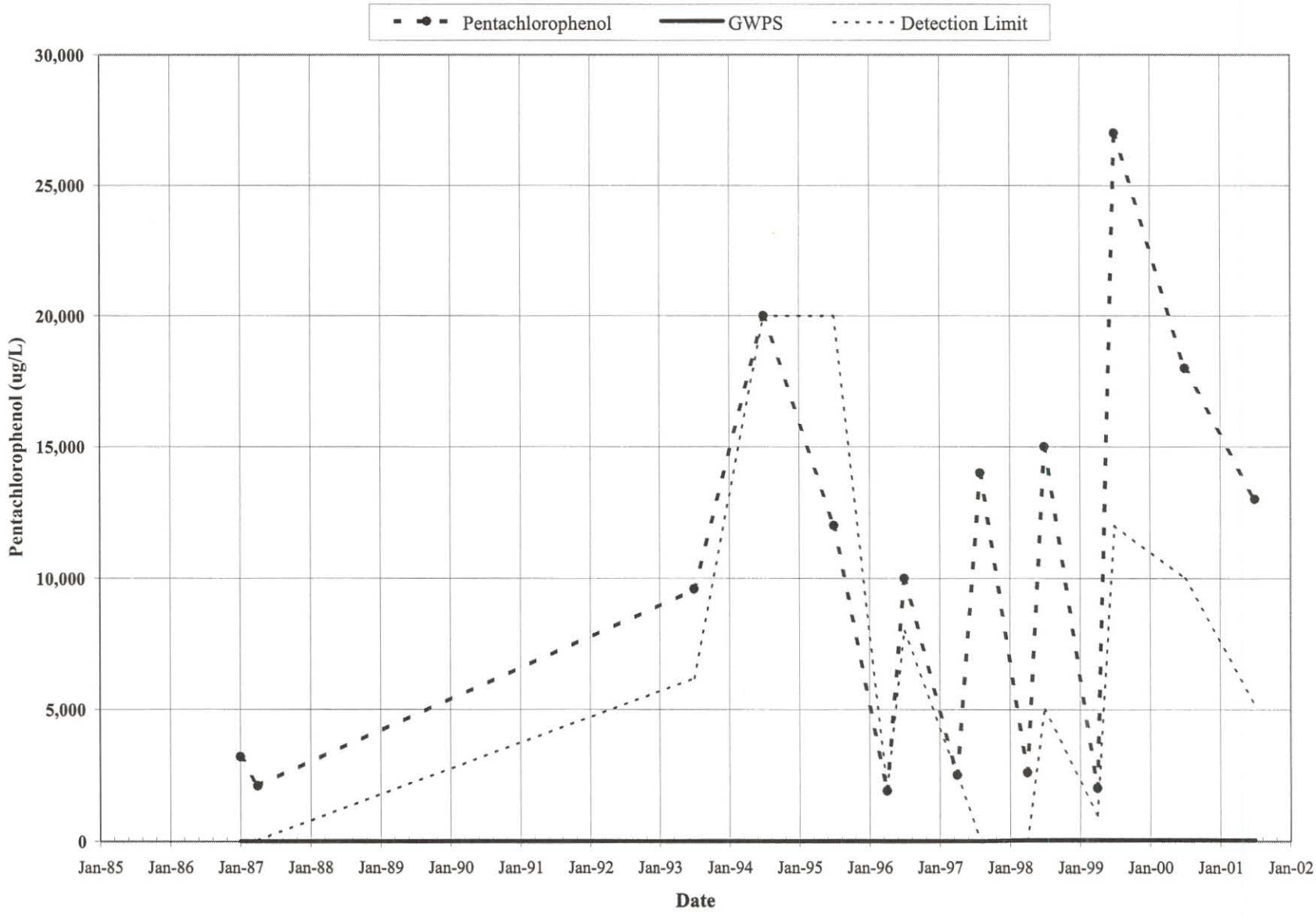


MW-14(S) 2,4-Dichlorophenol



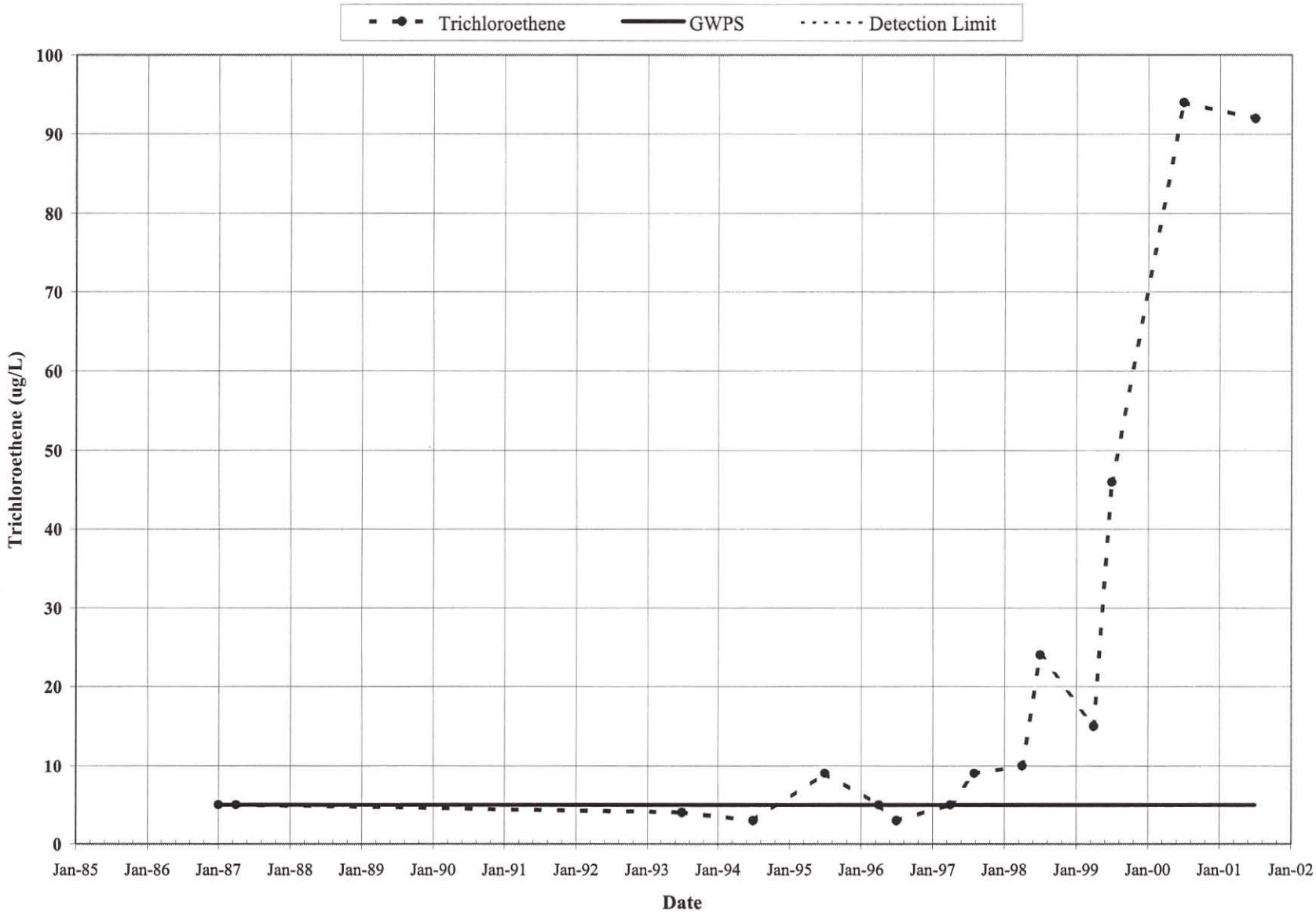
MW-14(S)

Pentachlorophenol

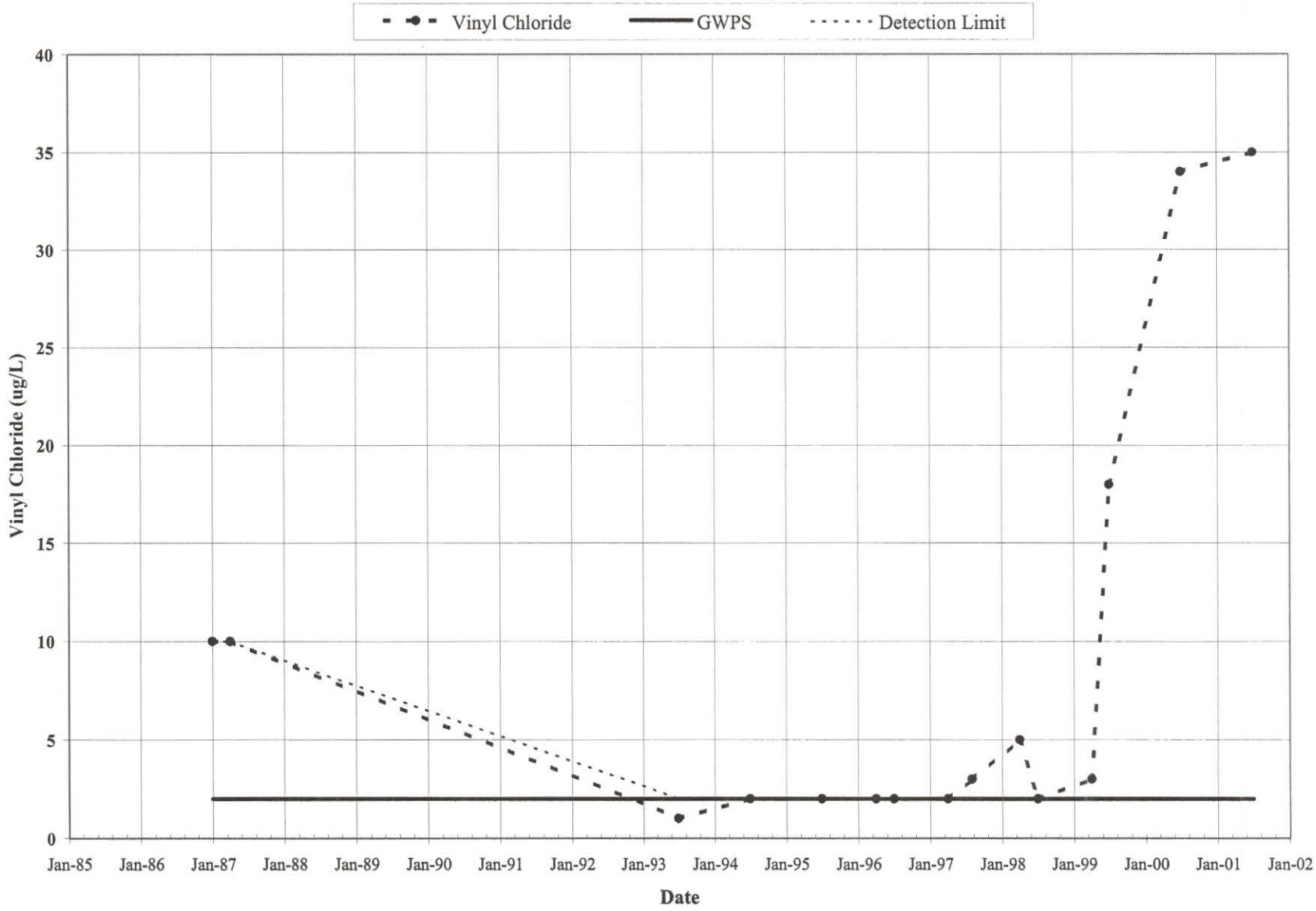


MW-14(S)

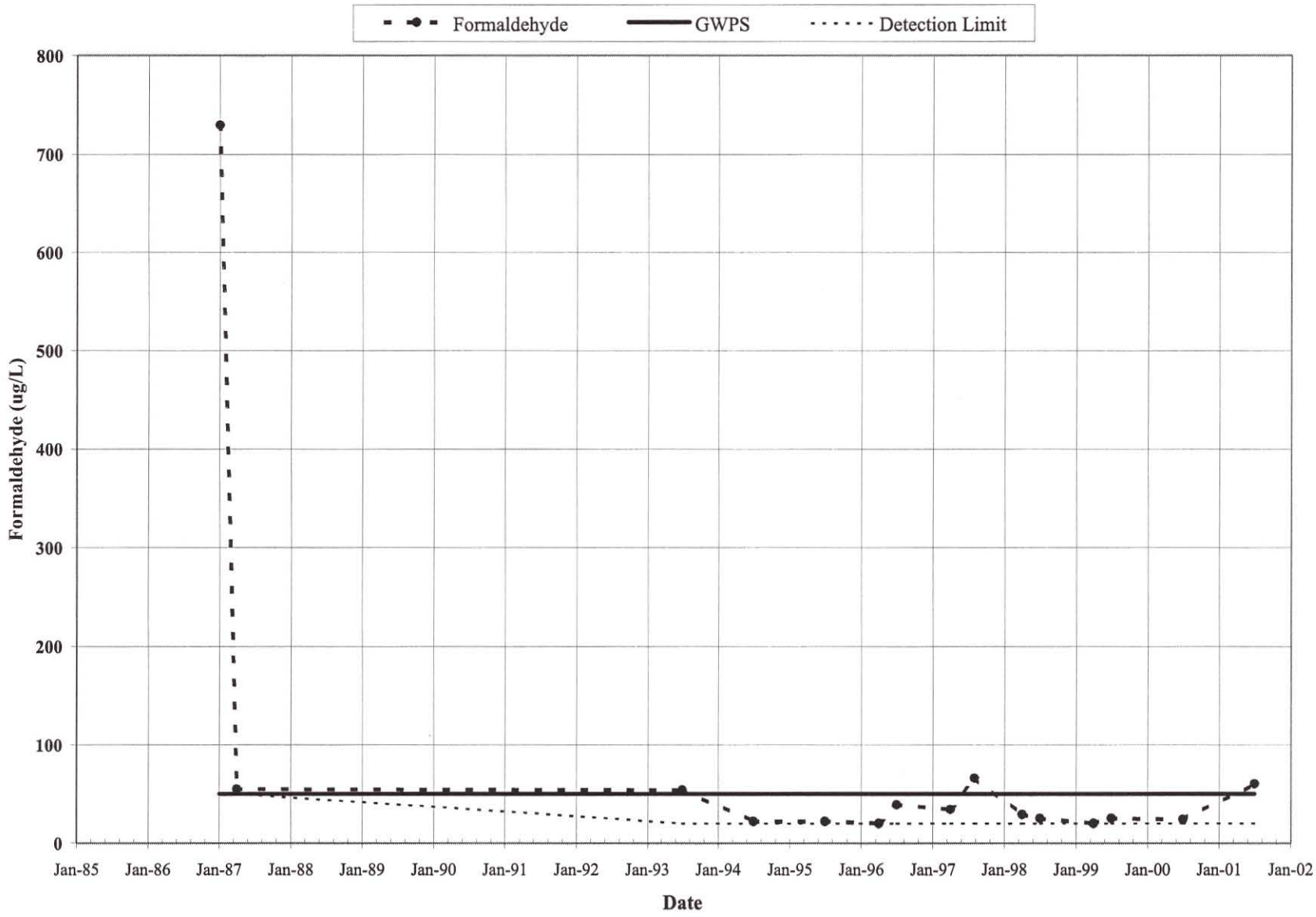
Trichloroethene



MW-14(S) Vinyl Chloride

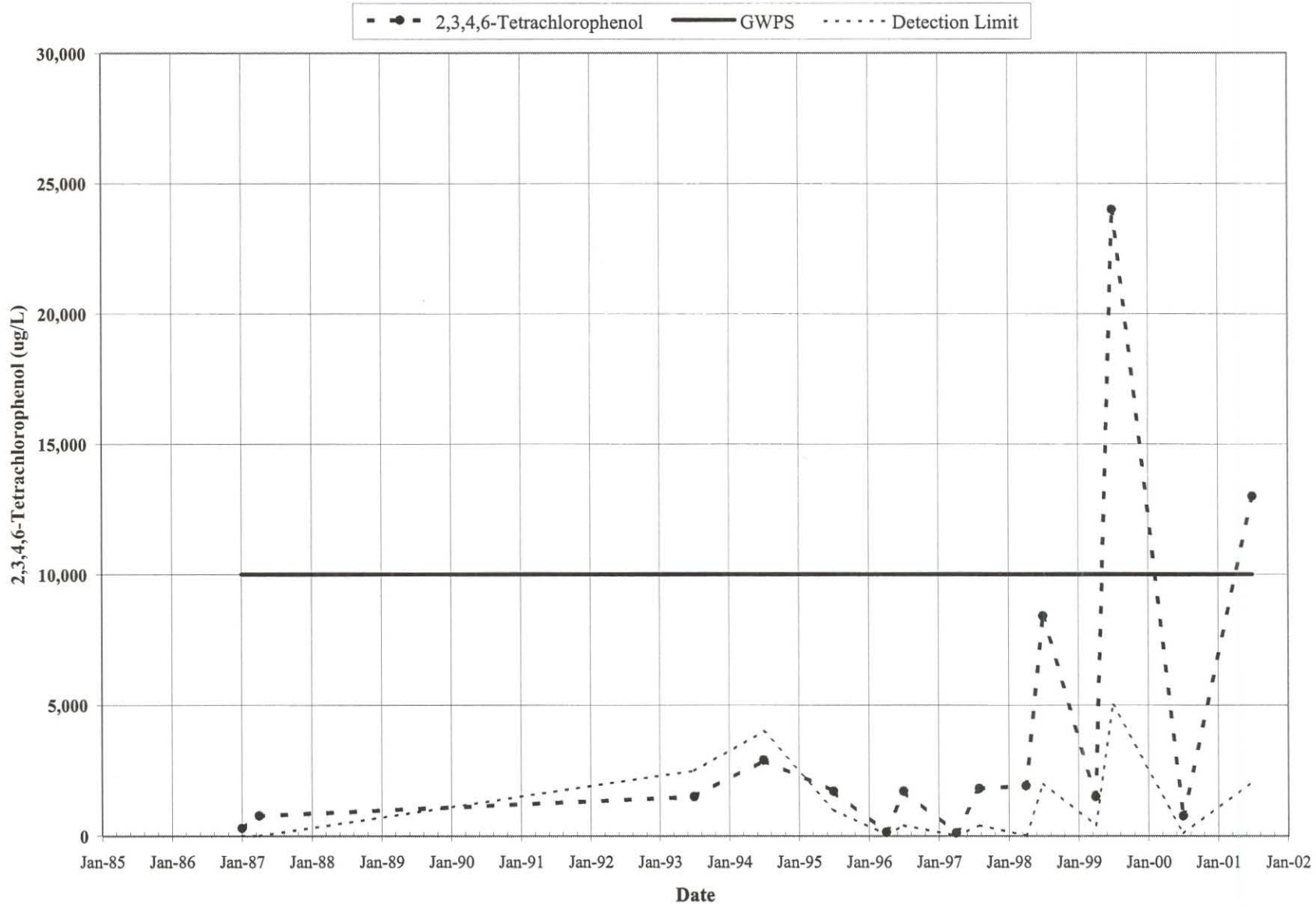


MW-14(S) Formaldehyde



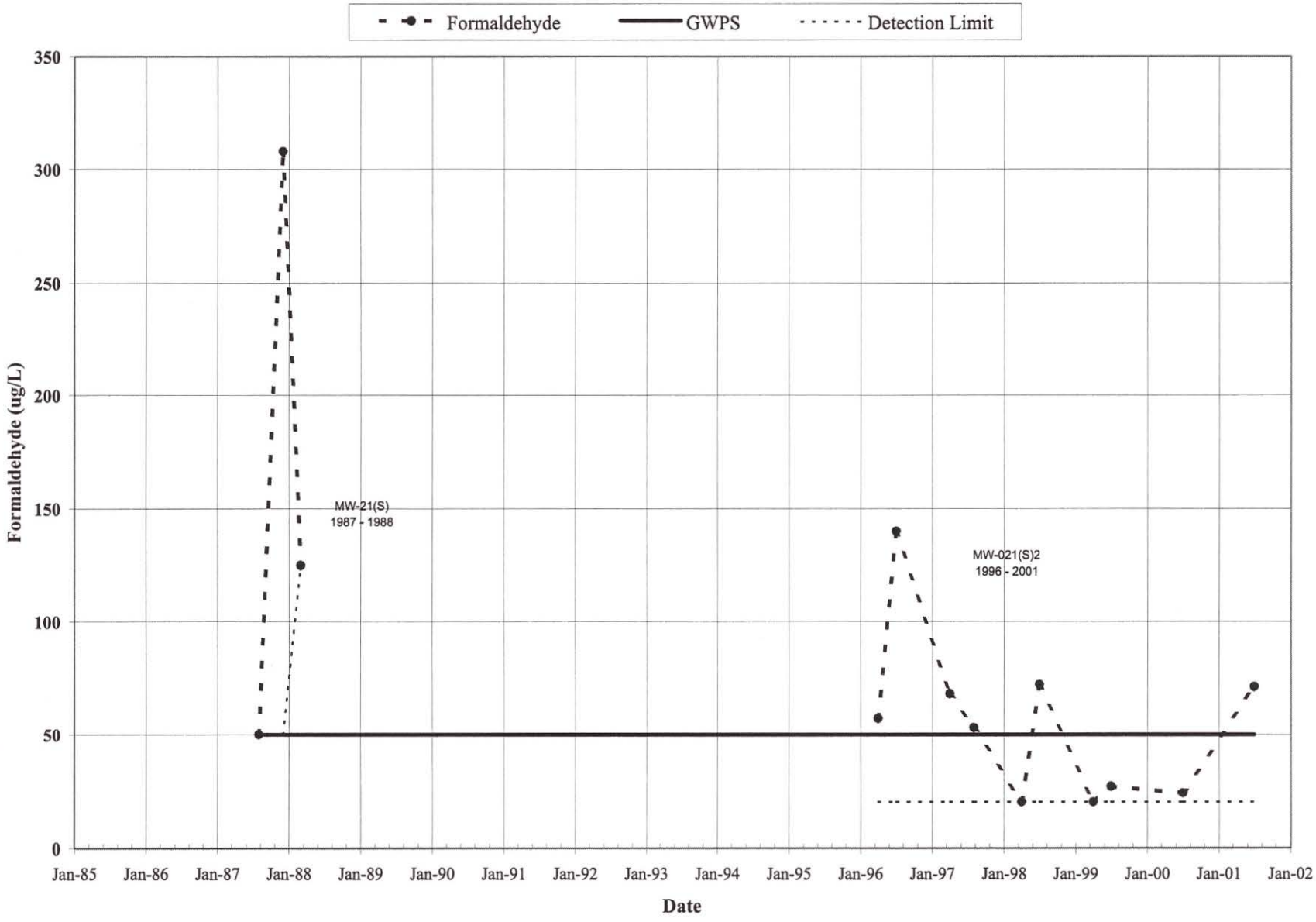
MW-14(S)

2,3,4,6-Tetrachlorophenol



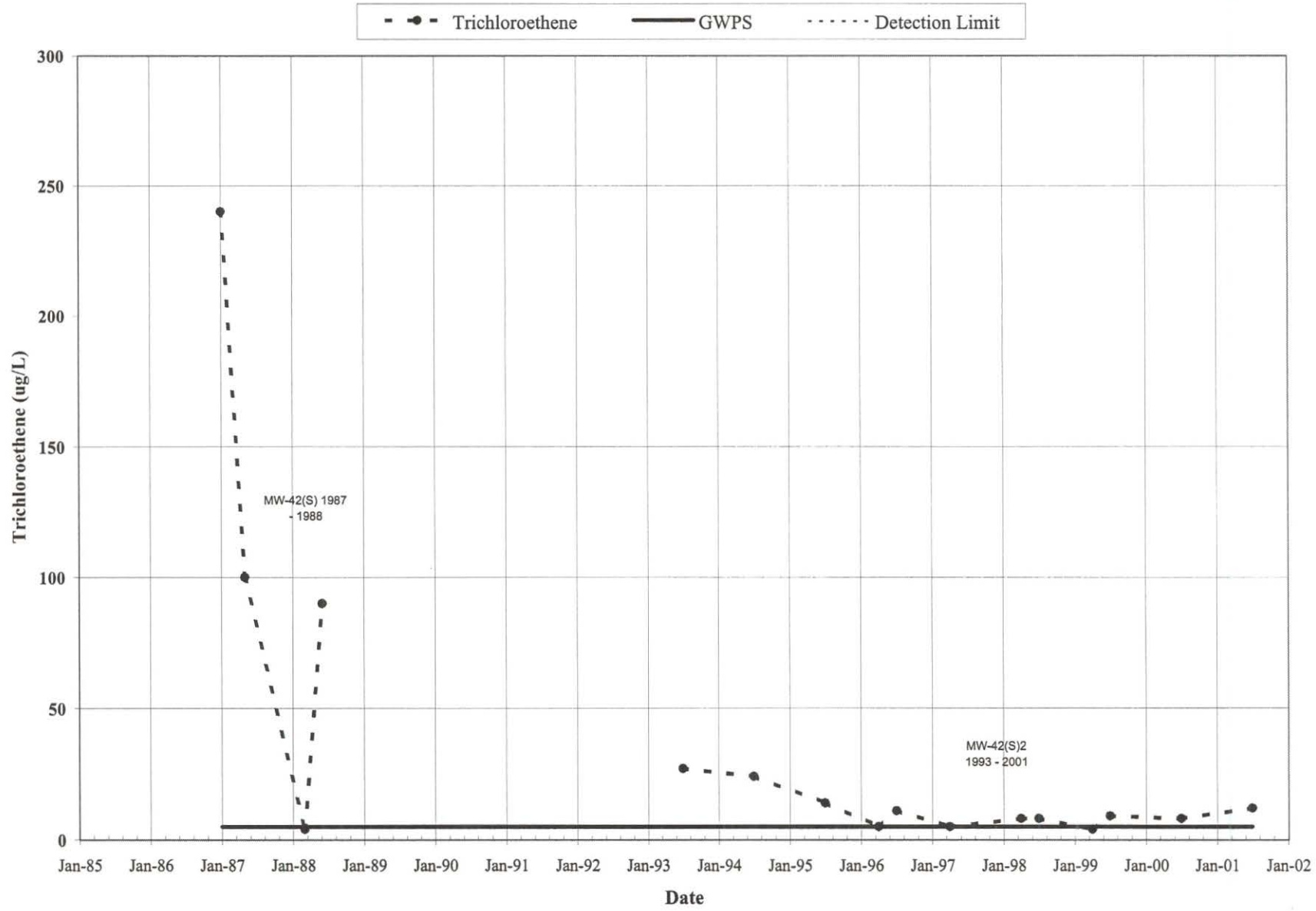
MW-21(S) and MW-21(S)2

Formaldehyde



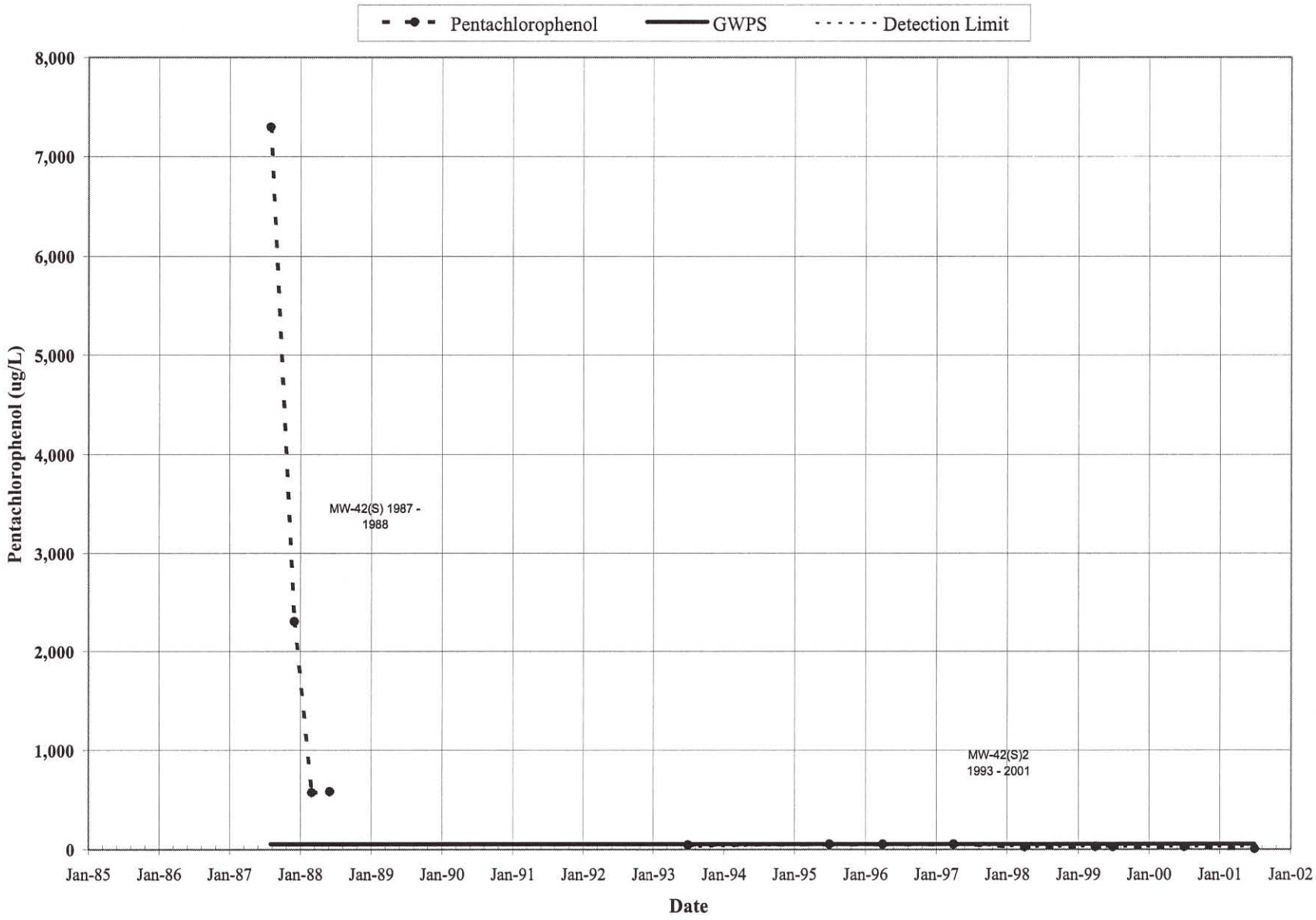
MW-42(S) and MW-42(S)2

Trichloroethene

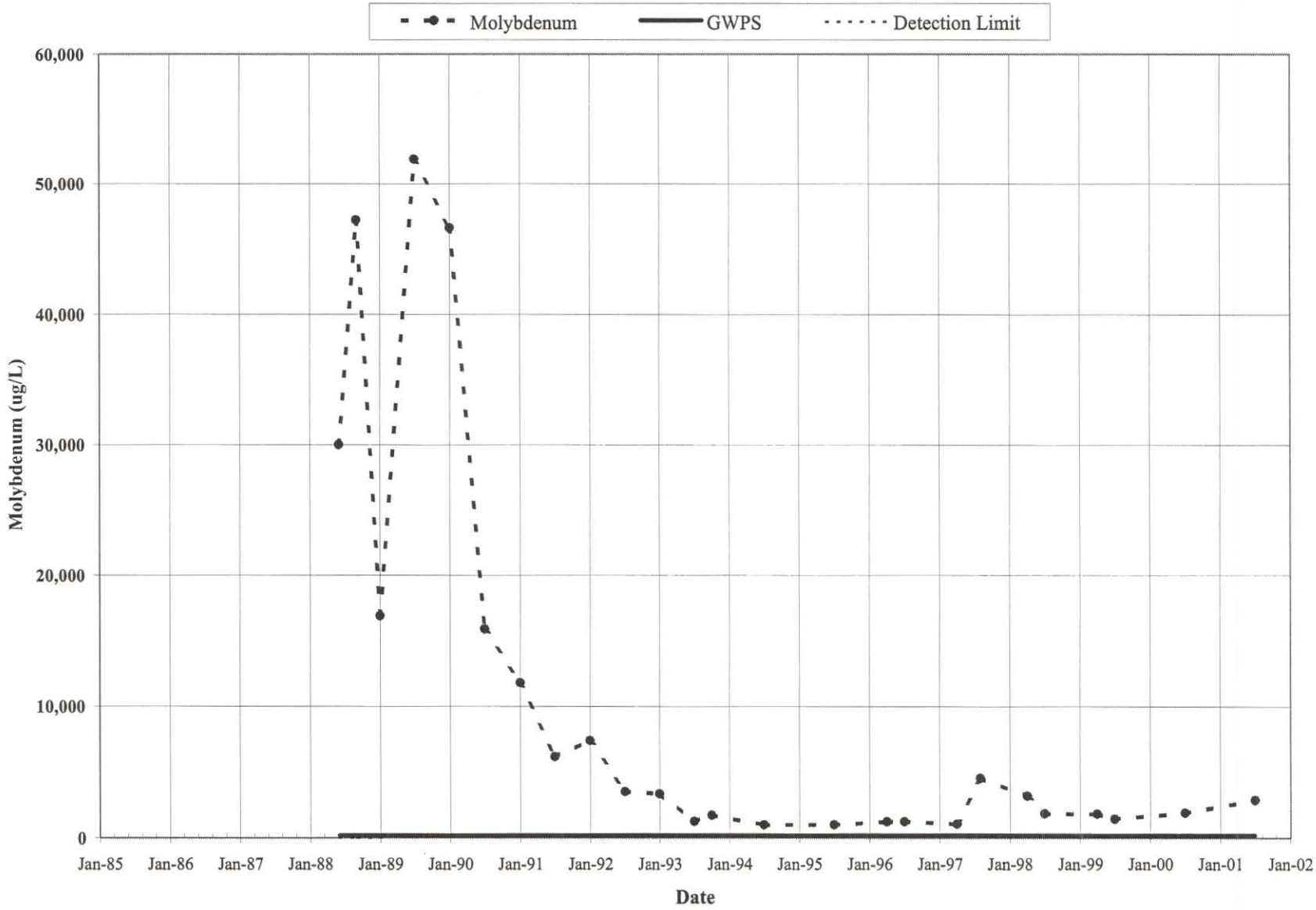


MW-42(S) and MW-42(S)2

Pentachlorophenol



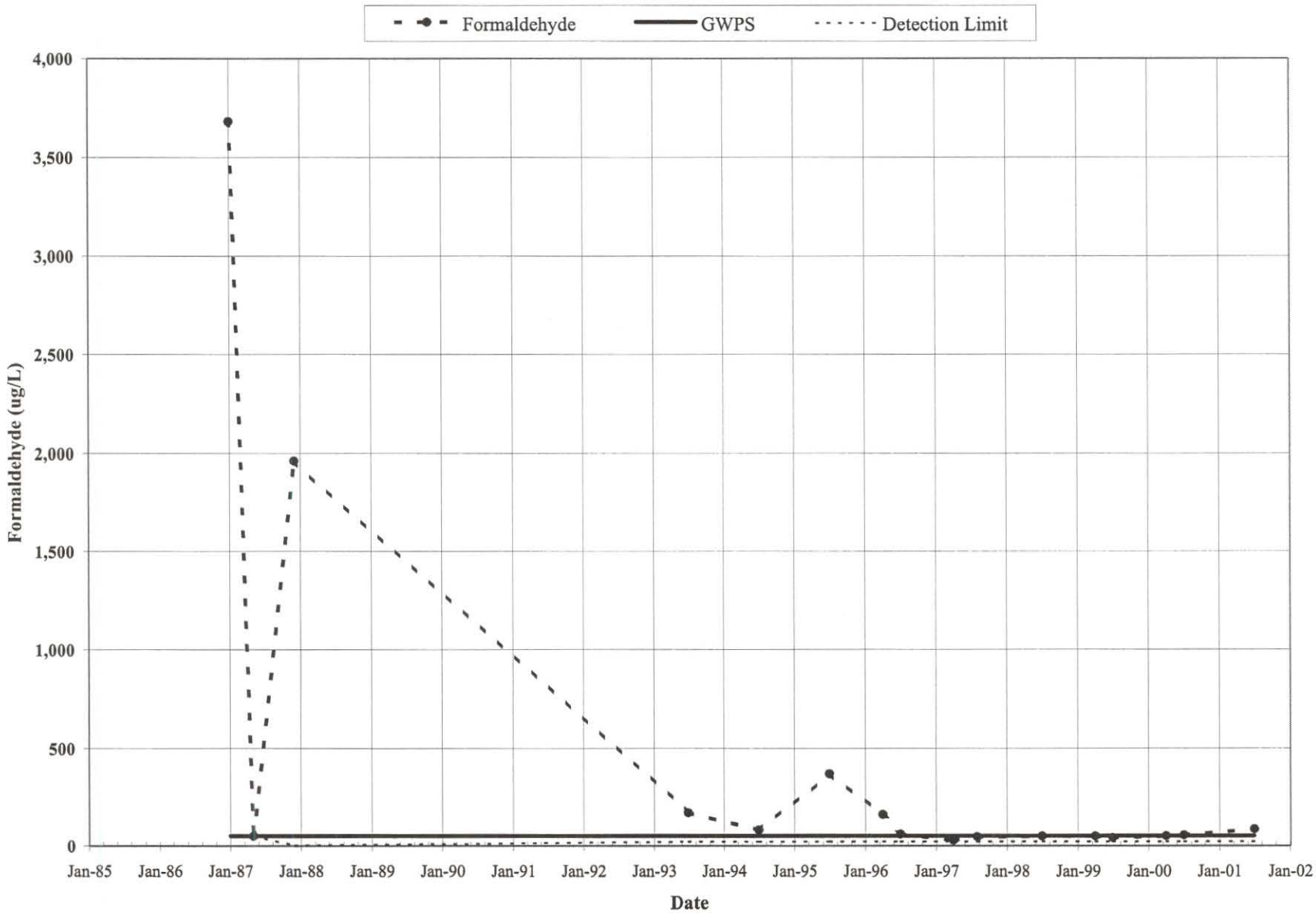
MW-56(S) Molybdenum



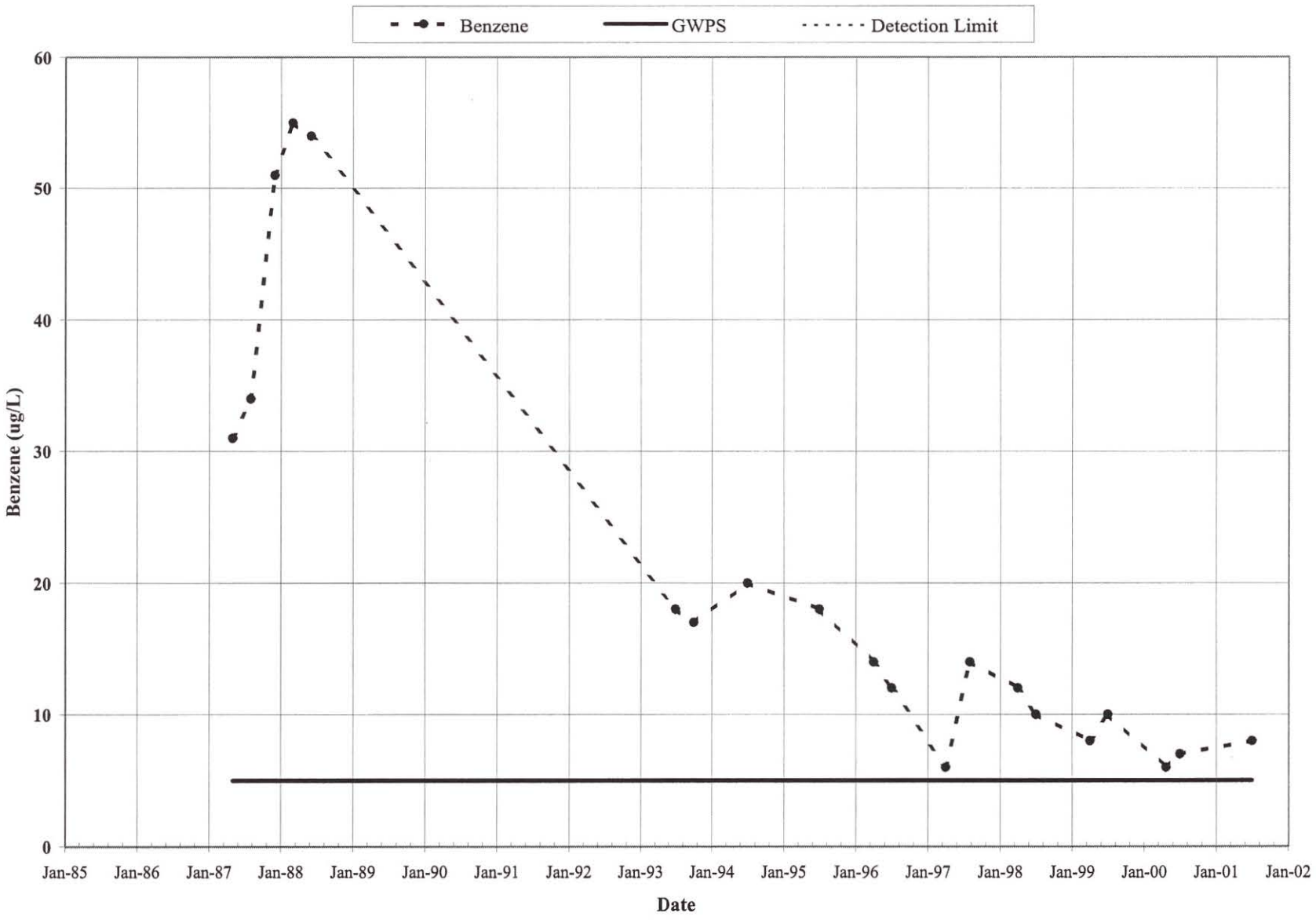
APPENDIX C

Intermediate Aquifer Time-Concentration Plots

MW-7(I) Formaldehyde

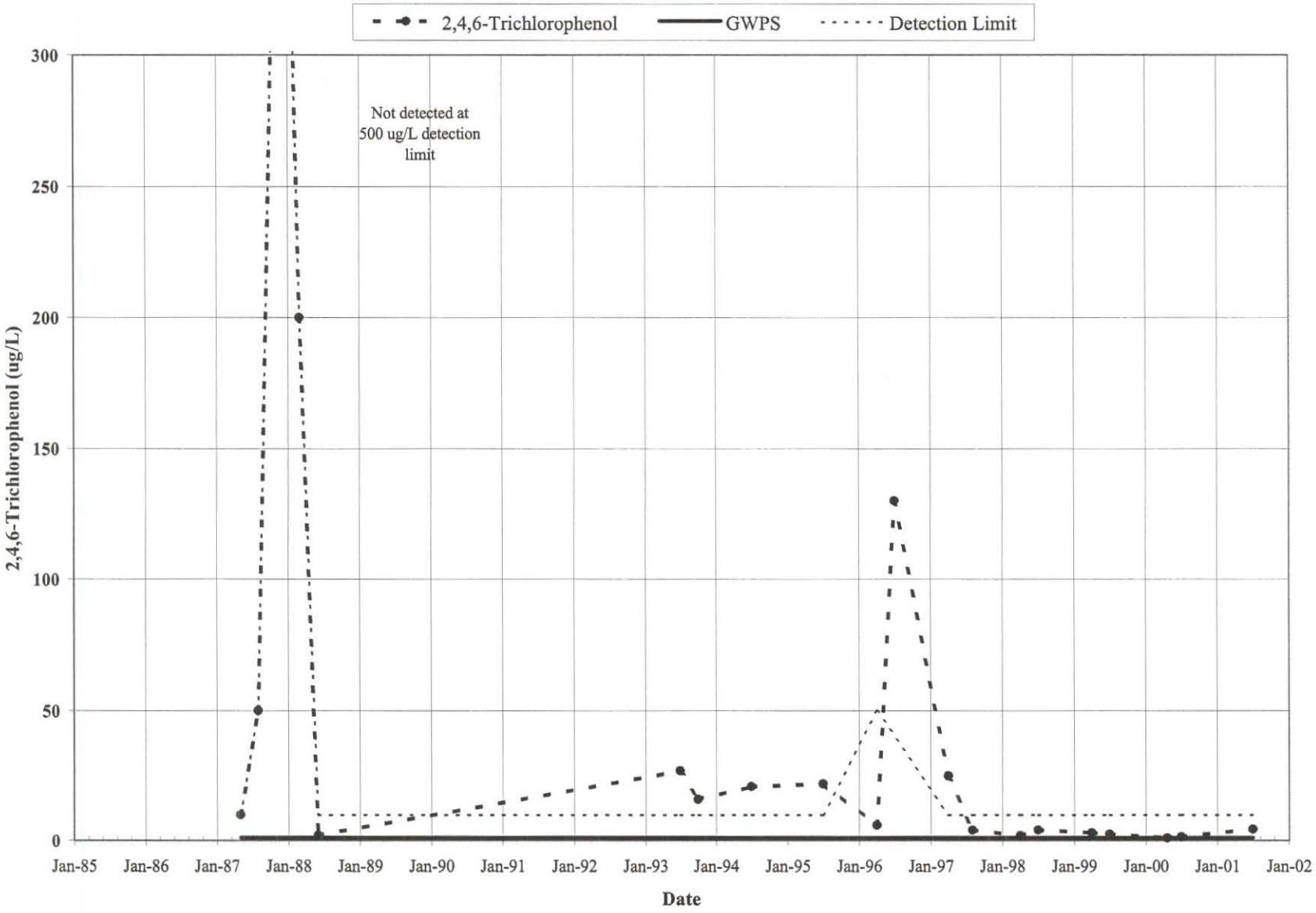


MW-30(I) Benzene



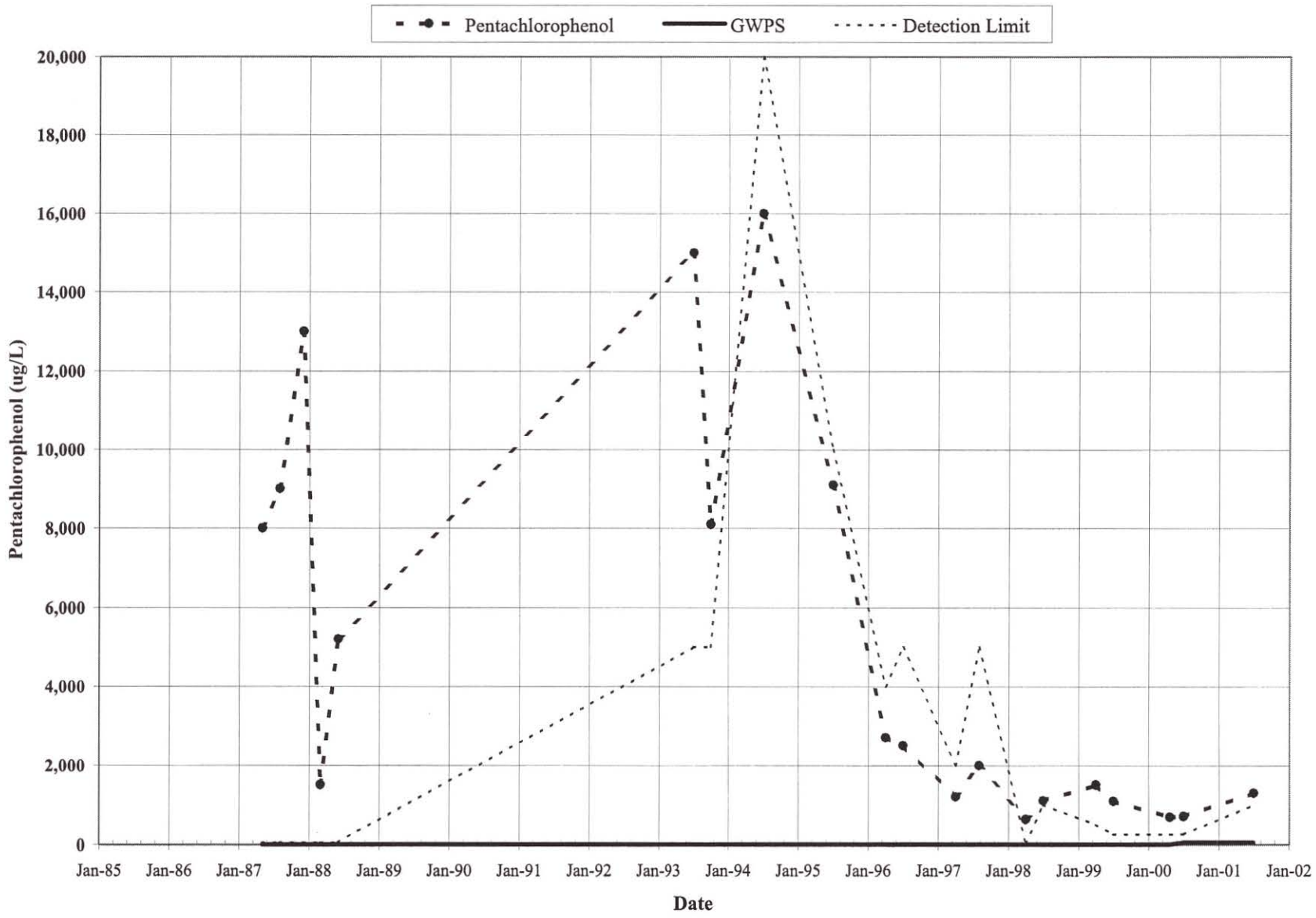
MW-30(I)

2,4,6-Trichlorophenol

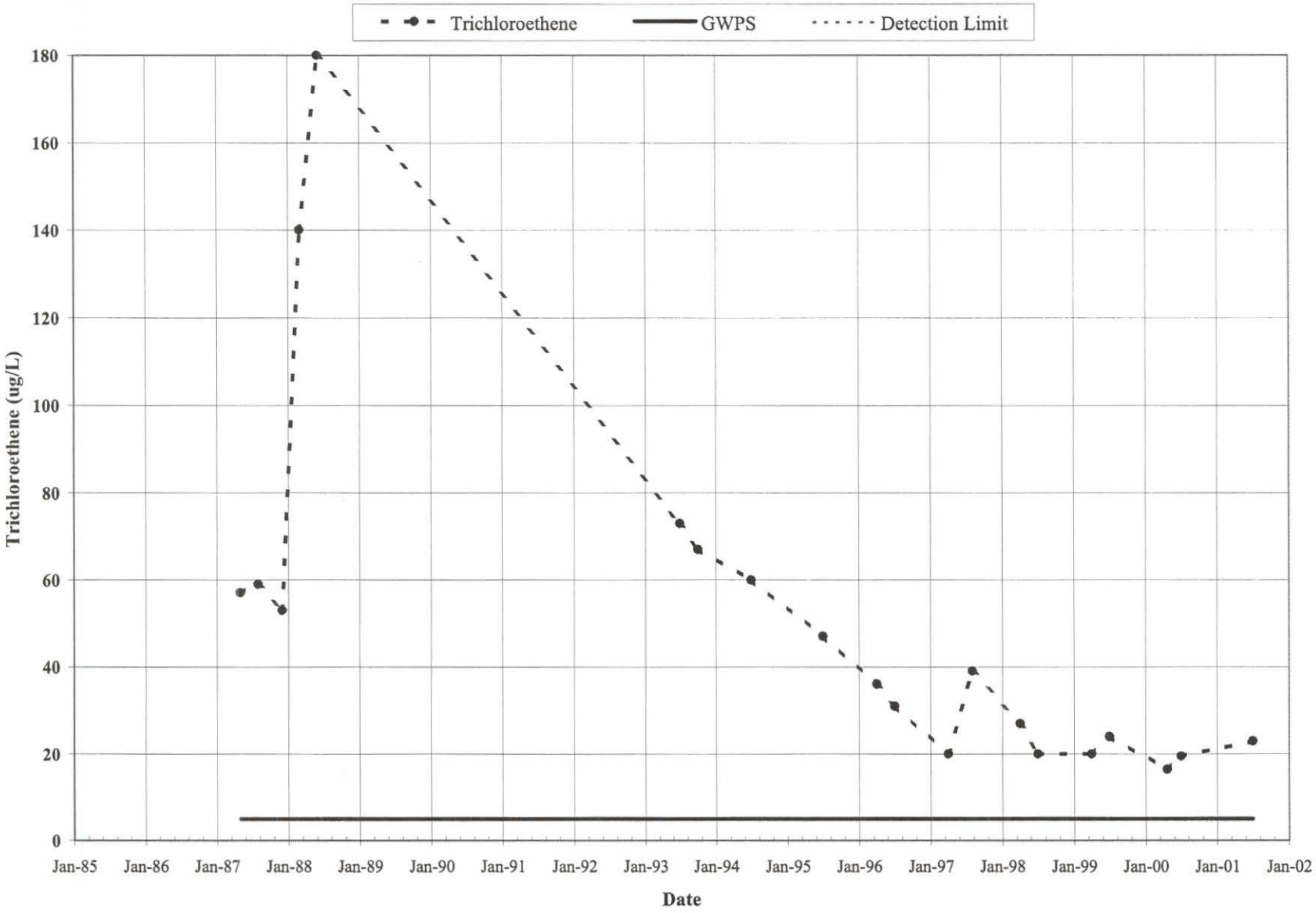


MW-30(I)

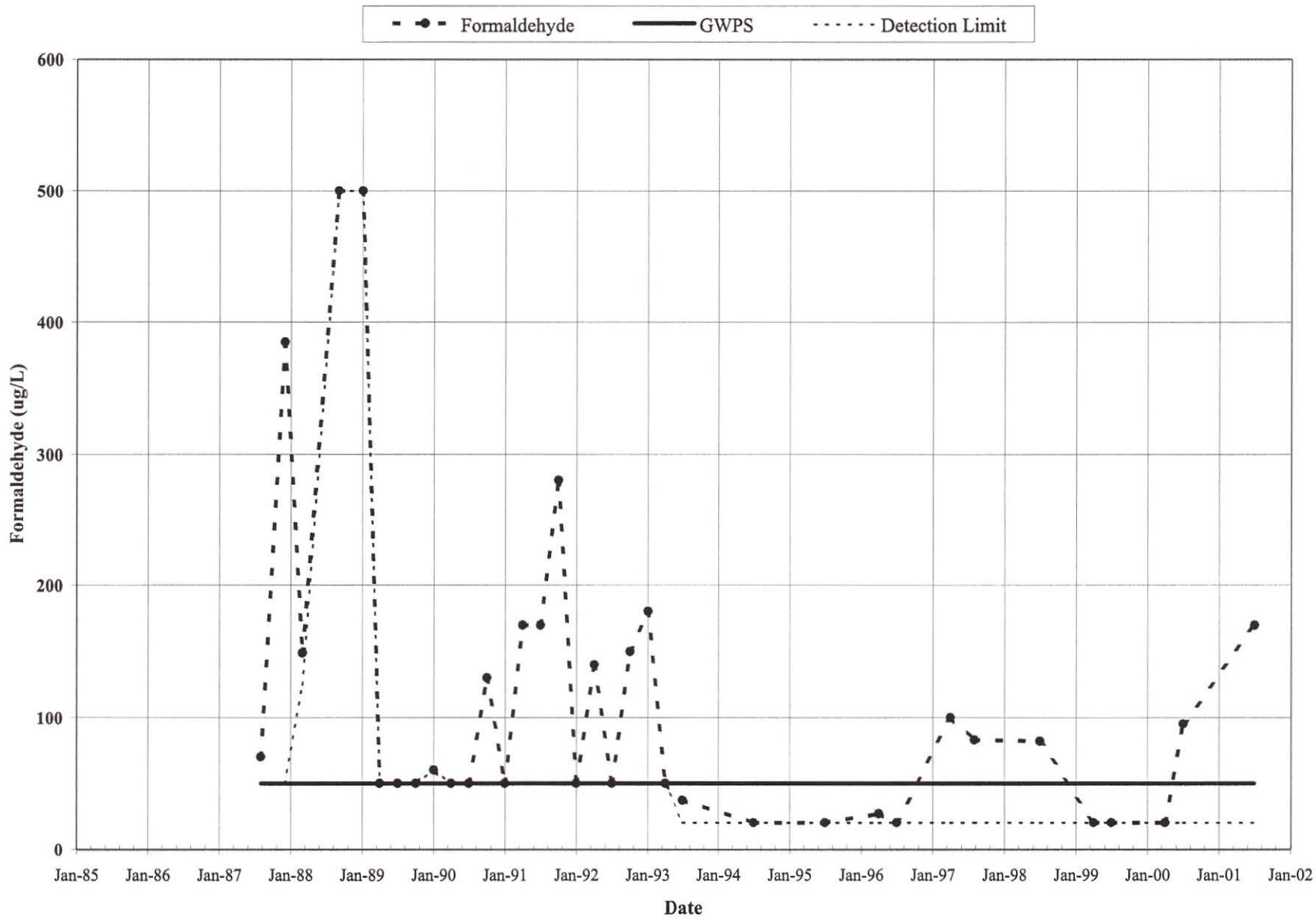
Pentachlorophenol



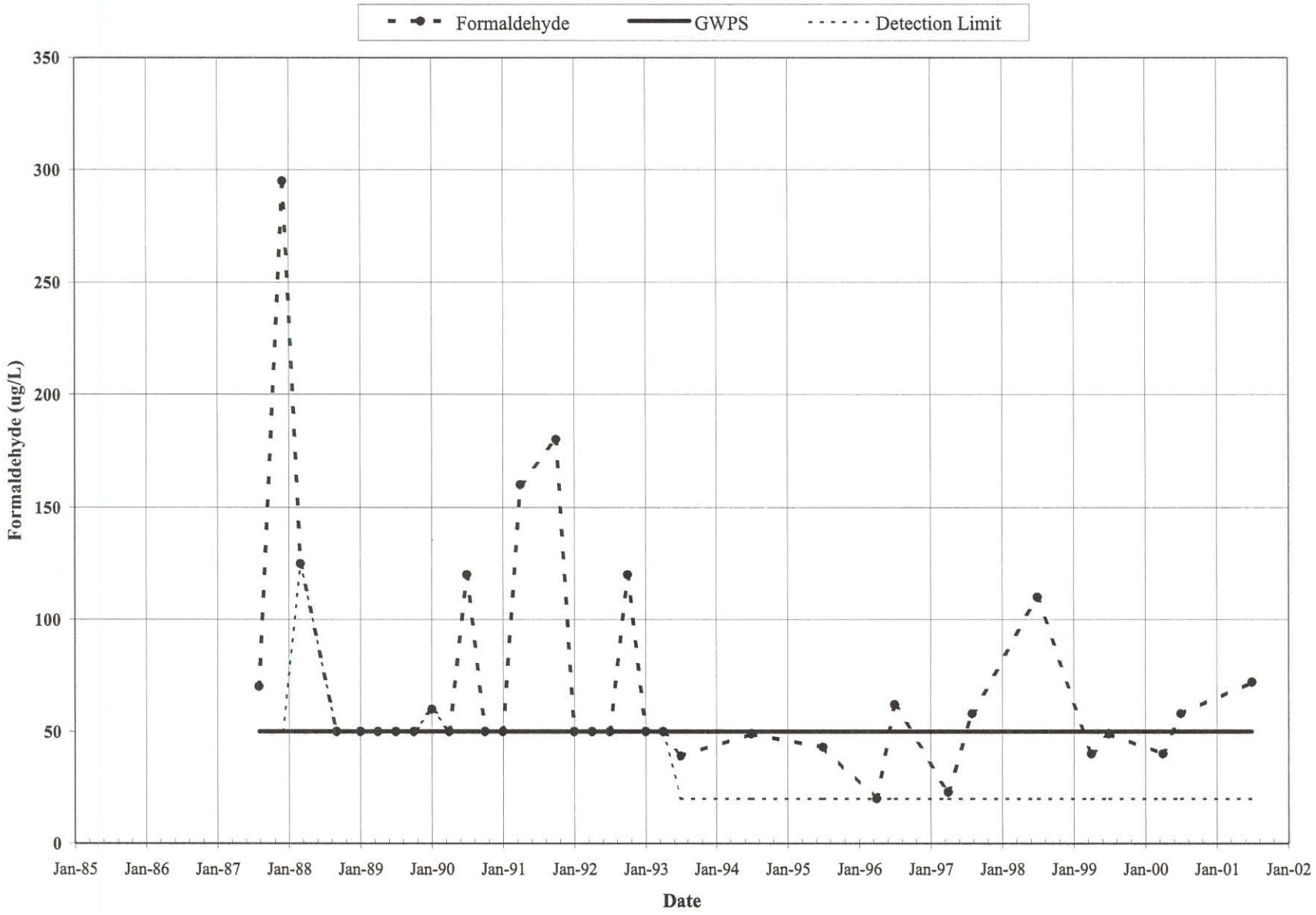
MW-30(I) Trichloroethene



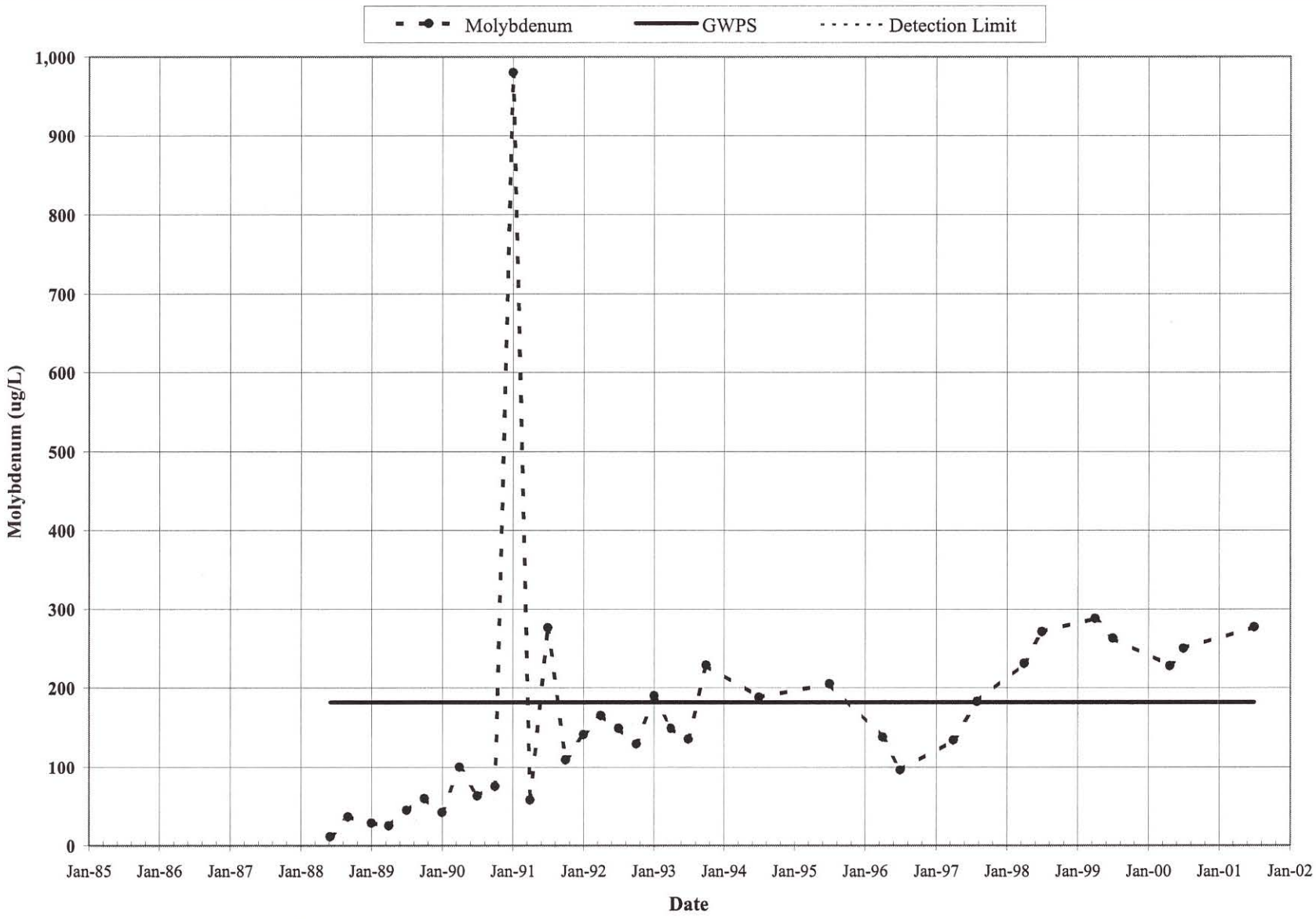
MW-36(I) Formaldehyde



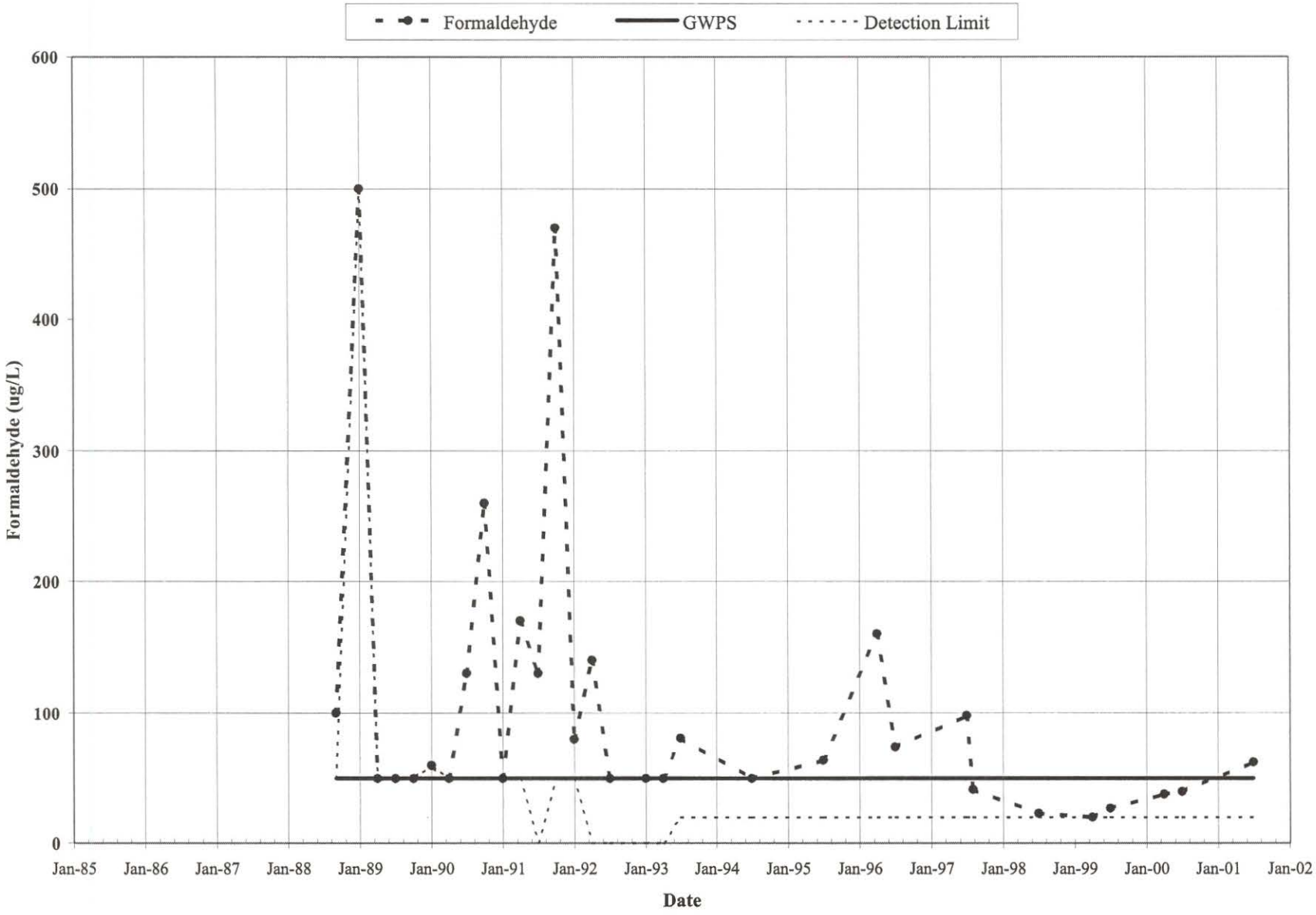
MW-39(I) Formaldehyde



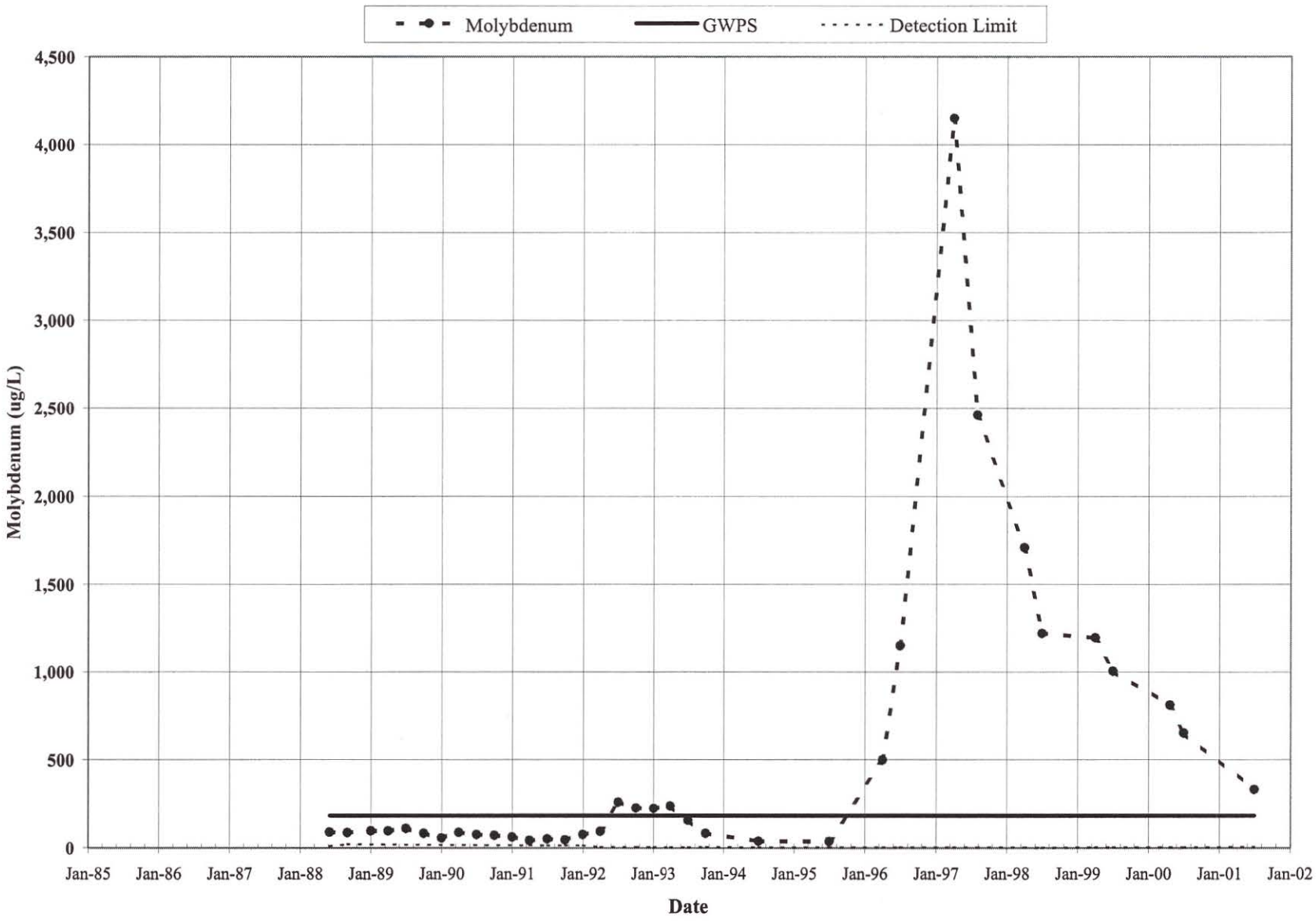
MW-45(I) Molybdenum



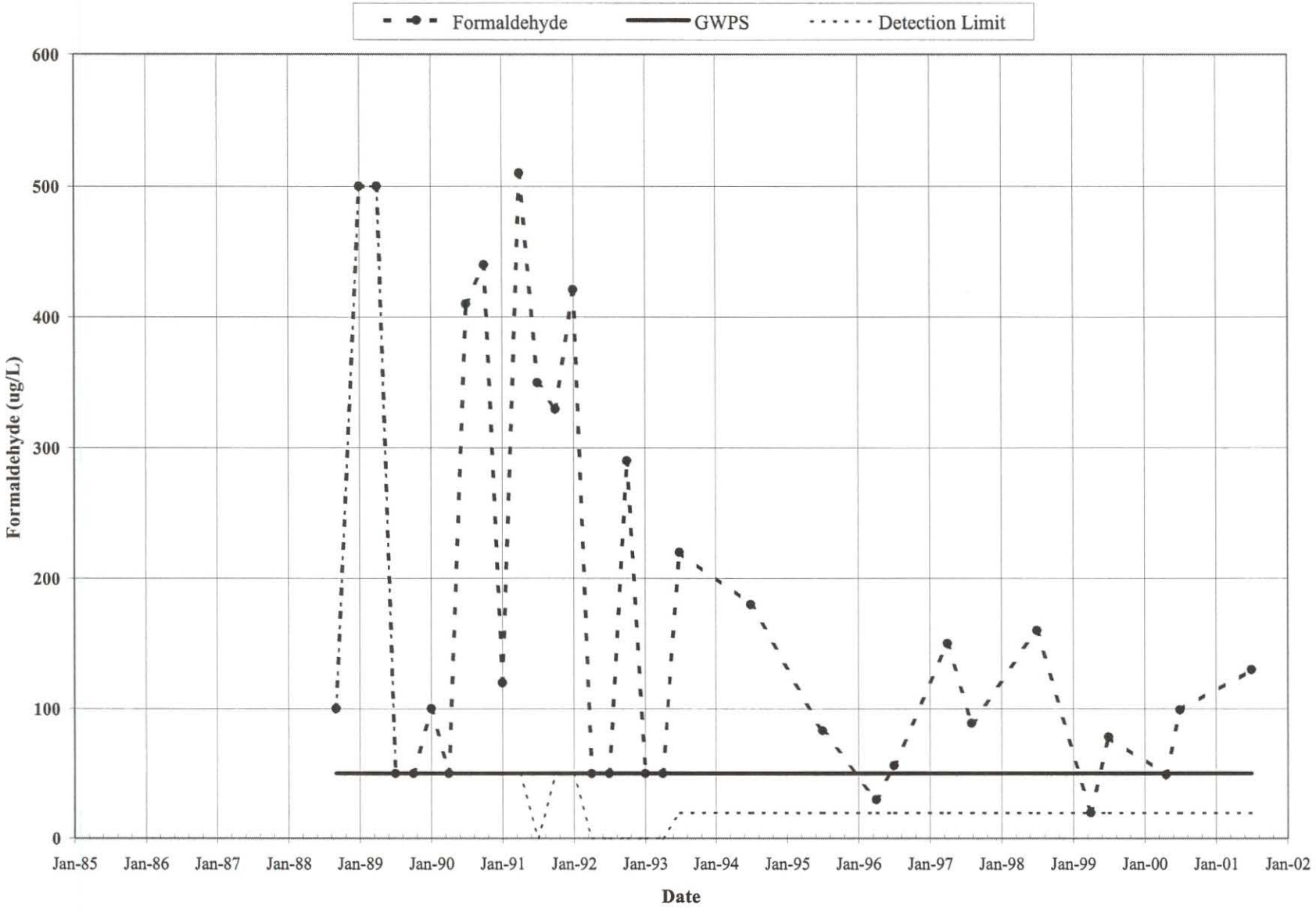
MW-46(I) Formaldehyde



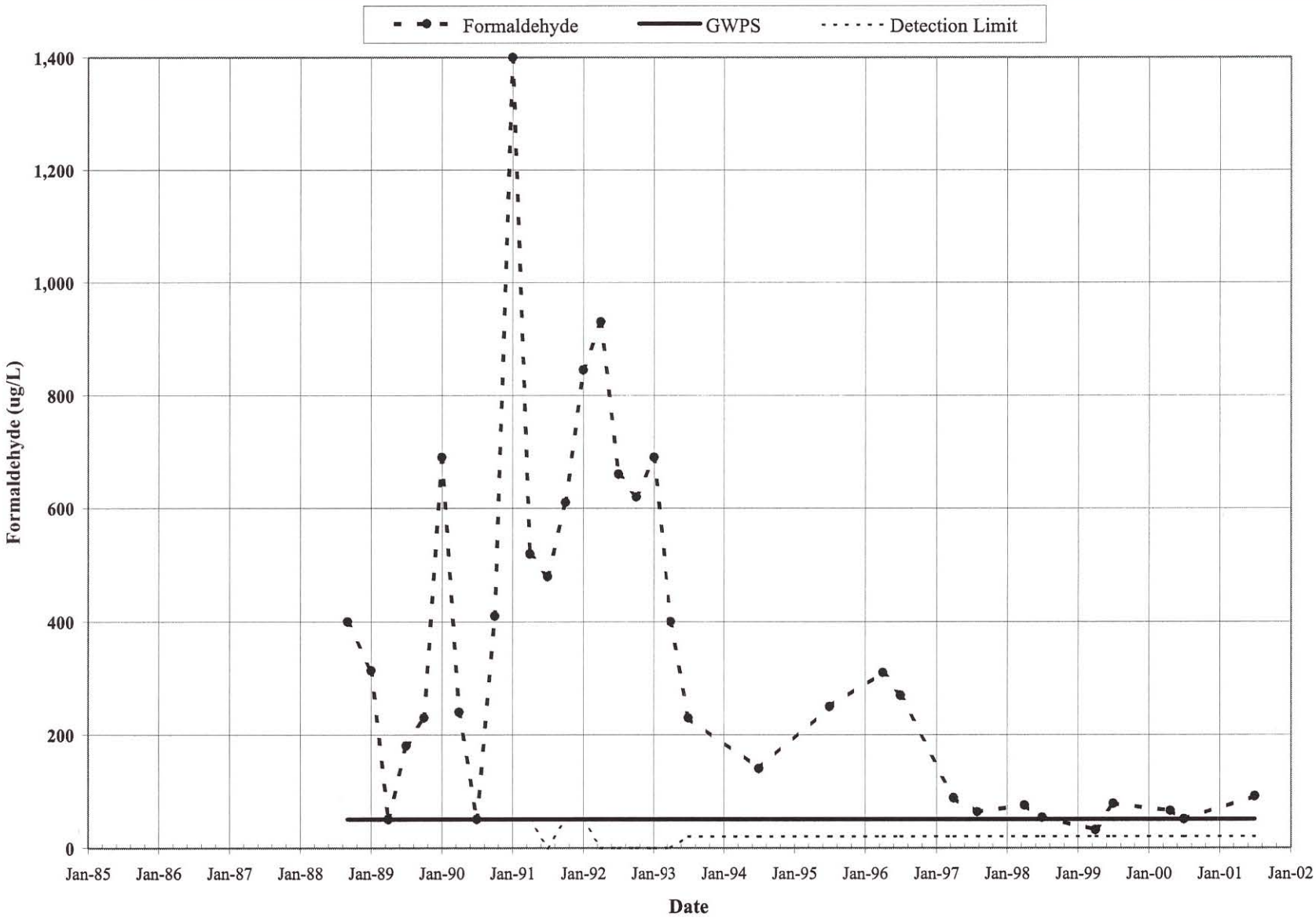
MW-48(I) Molybdenum



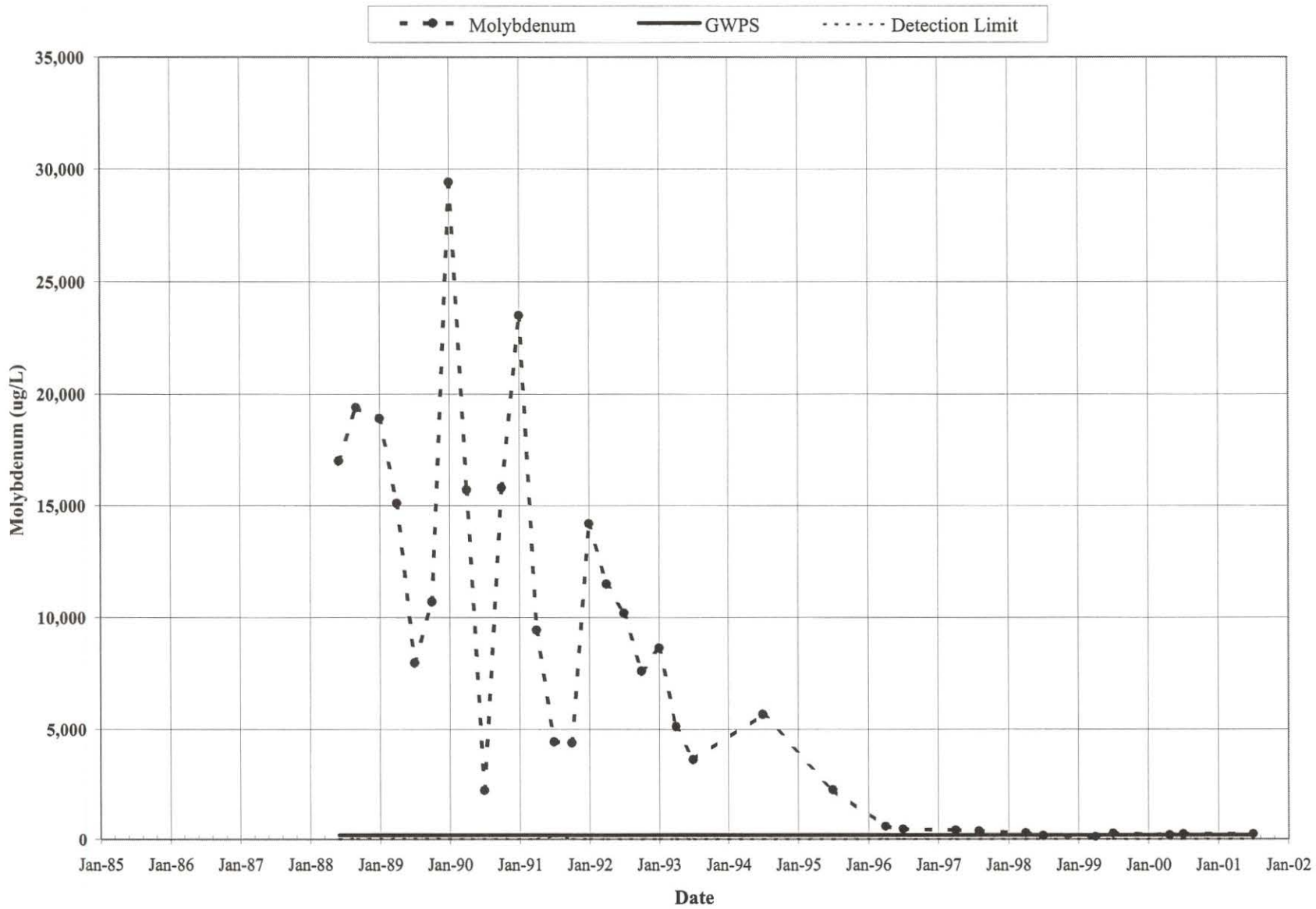
MW-50(I) Formaldehyde



MW-53(I) Formaldehyde



MW-53(I) Molybdenum



MW-53(I) **Vinyl Chloride**